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TENDERS.

SANITARY SCHEMES.

POONA CITY.

TO ALL WHOM IT MAY CONCERN.

The Poona City Municipality

PROPOSES to START by the beginning of 1921 the following WORKS:—

COMPLETING THE CITY DRAINAGE SYSTEM (approximate cost for City portion only) Rs. 700,000.

IMPROVEMENTS TO WATER SUPPLY DISTRIBUTION SYSTEM, Rs. 200,000.

CONVERSION OF EXISTING PRIVIES (about 8,000 in number) into Water Closets, Rs. 1,400,000.

The Works are expected to be finished in 1923.

Firms of reputation dealing in the various articles required for works mentioned above, Contractors having experience of the above class of work and Technical Experts and skilled workmen should write immediately to S. R. Bhagwat, Chief Officer, Poona City Municipality, giving specifications, price lists with special discounts, if any, for articles they deal in, or for any information they may require. K 735

TYNE IMPROVEMENT COMMISSION.

FERRYBOATS "THOMAS RICHARDSON" and "U.A. RITSON."

The Tyne Improvement Commissioners Invite

Tenders for the Supply of

TWO TAIL END SHAFTS, for each of the above named Ferryboats—Shafts to be of forged ingot steel, not less than 5½ in. dia under liners. Gunmetal liners to be contracted on, and shafts made and tested to Board of Trade requirements for Passenger Steamers, and to British Standard specifications for ingot steel forgings for marine purposes.

Tenderers to state when delivery could be given. A detailed sketch of the shafts required may be obtained on application to the undersigned, to whom Tenders in sealed envelopes endorsed on cover "Tender for Tail End Shafts," must be addressed and delivered not later than Monday 29th November, 1920. The Commissioners do not bind themselves to accept the lowest or any Tender,

By Order,
J. McD. Manson,
General Manager and Secretary.
Tyne Improvement Commission Offices,
Newcastle-upon-Tyne.
17th November, 1920. K 802

COUNTY BOROUGH OF WALLASEY.

GAS AND WATER DEPARTMENT.

TO ENGINEERS AND CONTRACTORS.

The Corporation of Wallasey invite

Tenders for:—

(1) The MANUFACTURE, DELIVERY and ERECTION of complete COKE-HANDLING PLANT at the Corporation Gas Works.

(2) The MANUFACTURE, DELIVERY and ERECTION of TWO ELECTRICALLY OPERATED CAPSTANS, also at the Gas Works. Plans, Provisional Specifications, etc., may be seen, and the site inspected on application to the Engineer, Mr. J. H. Crowthers at his Offices at the Gas Works of the Corporation, Limekiln Lane, Wallasey.

Contractors may tender for either one or both of the above sections, stating the amounts separately.

Sealed Tenders, addressed to the undersigned and endorsed "Coke Plant" and/or "Capstans," "Gas Extensions" to be delivered per post to my office not later than Tuesday, the14th December, 1920. Tenders arriving at a later time cannot be considered.

The is no special Form of Tender.

The Contractor will be required to enter into a bond with approved sureties for the due performance of the Contract.

The Corporation do not bind themselves to accept the lowest or any Tender.

Dated this 10th day of November, 1920.

R. W. Cook,
Town Clerk.

Town Hall,
Wallasey. K 736

Tenders are Invited for the

following:—

ONE SET of BELT-DRIVEN BOILERMAKER'S ROLLS, suitable for dealing with ¾ in. plates, 8 ft. 6 in. long, and capable of bending these to 8ft. dia. circle, provided with means of removing housing on top roll to allow of work being withdrawn, and

ONE BELT-DRIVEN PLATE EDGE PLANING MACHINE, to deal with plates up to 15 ft. 0 in. long.

Please supply full particulars to the

CHIEF MECHANICAL ENGINEER,
South Metropolitan Gas Co.,
709, Old Kent Road,
London, S.E. K 784

TO ENGINEERS.

THE COMMISSIONERS OF H.M. WORKS, &c. are prepared to receive

Tenders before Eleven

a.m. on (a) and (b) Wednesday, 8th December and (c) Thursday, 9th December, 1920, addressed to THE SECRETARY, H.M. Office of Works, &c., Storey's Gate, Westminster, London, S.W. 1, for the SUPPLY of ENGINEERING LABOUR-in-DAYWORK in (a) the BIRMINGHAM District; (b) the BRISTOL District (Electrical and Mechanical) and (c) the LIVERPOOL District, for the period of ONE YEAR from the 1st January, 1921.

Forms of Tender and all particulars may be obtained on application to THE DIRECTOR OF CONTRACTS, at the above-mentioned address. K 738

G. R.

MINISTRY OF MUNITIONS.
BY DIRECTION OF THE DISPOSAL BOARD
(Huts & Building Materials Section).

For Sale by Public Tender.

Closing date DECEMBER 4th, at Twelve noon.
At NATIONAL PROJECTILE FACTORY, PONDERS END STATION, MIDDLESEX.

4 tons (about), STEEL STANCHIONS, slightly rusty, sizes from 4½ in. by 1½ in. to 10 in. by 5 in. lengths 7 ft. to 20 ft.

Permits to view and tender forms to be obtained upon application to DISPOSAL OFFICER, Eastern Area, 15, Cromwell Road, S.W.7. K 824

G. R.

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BY DIRECTION OF THE DISPOSAL BOARD.
(Plant & Machinery Section.)
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Sale by Public Tender.

ONE ELECTRIC COAL GRABBING CRANE.
Hammer head type fitted with Hoisting, Traversing, and slewing motions, with all necessary Electrical and Mechanical gear. Grab by Priestman Bros., of 4 rops, centre shaft design.
Grab capacity, Flush 34 cu. ft.
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LYING AT: Messrs. Herbert Morris, Ltd.(makers), Loughborough. Reference M.K. 36138.

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One ditto as above, but working load 1½ tons. Test load 2¼ tons. Reference M.K. 47344.

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One Hand Travelling Crane. No gear for slewing motion as Crane can be easily slewed by hand. 4 Carriage wheels, single flange C.I. 2 ft. dia. Radius of Crane is 24 ft. and height from underside of Hook to Crane 34 ft. Rope of flexible wire with factor of safety of not less than 8. Necessary Brakes for lifting and Travelling fitted. Rail gauge 4 ft. 8½ in. Working load 10 cwt. Test load 15 cwt. By G. Russell & Co. Reference M.K. 47342.

Full Specification of Grabbing Crane, detailed particulars of other Cranes, Permits to view, and tender forms can be obtained on application to the Controller,

D.B.I.B.
Charing Cross Huts, W.C. 2.

Tenders to be completed and returned on or before ten a.m. on the 7th December, 1920. K 647

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A Lecturer is Required for

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A. E. COLLIS, M.I.M.E., Principal.

Applications are Invited for

the POST of ASSISTANT LECTURER in the Mechanical Engineering Department—to commence duties early in January, 1921.

Workshop and Drawing Office training and teaching experience in Drawing and Design essential. Experience in Engineering Laboratory a further recommendation. University Degree or equivalent qualifications desirable.

Commencing salary £330 to £360 per annum according to qualifications and experience, rising by annual increments of £15 to £450.

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Two Lecturers in Mechanical

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Applications should be submitted (not later than December 13) in covers marked "C.A." and addressed to the SECRETARY, Board of Education, Victoria and Albert Museum, South Kensington, S.W. 7. Scottish candidates should apply to the SECRETARY, Scottish Education Department, Whitehall, London, S.W. 1. K 778

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The Council Invites

Applications for the following

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JUNIOR LECTURER AND DEMONSTRATOR IN THE DEPARTMENT OF MECHANICAL ENGINEERING.

Applicants must have had technical training, workshops, and preferably also drawing office experience. Salary £324 per annum, rising by £27 10s. annually to £464. War bonus at Government rates; at present £26 per annum for single man, £114 if married. Appointment probationary for first two years. Applicant with special qualifications may possibly be appointed at higher rate than specified. Duties commence about 1st March, 1921. Allowance for travelling expenses £40. Half salary from sailing until arrival. Medical certificate required before appointment. Age to be stated. Applications and testimonials, all in triplicate, to be sent by 6th December to CHALMERS, GUTHRIE & Co., Ltd., 9, Idol Lane, London, E.C. 3. K 669

CHESHIRE COUNTY COUNCIL.
EDUCATION DEPARTMENT.

NORTHWICH VERDIN TECHNICAL SCHOOL AND SCHOOL OF ART.

Principal: D. N. Griffiths, B.Sc., A.M.I.Mech.E.

Applications are Invited for

the undermentioned POSTS:—

1. PRINCIPAL of the above-named School and Headmaster of the Voluntary Day Continuation School connected therewith. Candidates should possess a good degree in Engineering or an equivalent qualification. Inclusive annual salary £550–£25–£700.
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County Education Offices,
City Road,
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Preference given to candidates who have served, or attempted to serve, with H.M. Forces. Apply to Education Officer (T.1a), Education Offices, Victoria Embankment, W.C. 2 (stamped addressed foolscap envelope necessary), for form of particulars, to be returned by 11 a.m. on 24th November, 1920. Canvassing disqualifies.

James Bird,
Clerk of the London County Council.
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Branch of well-known British Engineering Company. Sound business and technical experience essential; knowledge of Hindustani desirable; accustomed to control of European and native staff. Only first-class applications, accompanied by full particulars and recent references, will be considered. —Address, K 766, Offices of Engineering.

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Engineering Works in France. Must have an up-to-date knowledge of Engineering practice, including Smiths and Drop-stamping. Must speak French fluently. Good house and garden available. —Address, K 820, Offices of Engineering.

Assistant Inspector of

Mechanical Work REQUIRED for large Electrical Machine Shop manufacturing Standard and Traction Motors. Some Electrical knowledge desirable, but only capable men used to high-class repetition work and able to make accurate measurements need apply, stating age, experience and wages required.—Address, K 783, Offices of Engineering.

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for Armature Winding Shop and Coil Making Departments, to check details, winding connections and make usual shop tests. State age, experience and wages required.—Address, K 784, Offices of Engineering.

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PROGRESSIVE POSITION is OPEN to first-class Man who can get maximum results from group of modern shops. Highest Grade Engine Castings, Details up to 15 tons weight. Output round 250 tons per week. Only First-class man with High Technical and Practical knowledge, and with proved record in similar position need apply, stating age, salary expected &c., in confidence.—Address, K 742, Offices of Engineering.

LONDON COUNTY COUNCIL.

TRAMWAYS DEPARTMENT.

Applications are Invited for

the POSITION of ASSISTANT REPAIR DEPOT SUPERINTENDENT at the Central Repair Depot of the Council's Tramways, at a salary of £300 a year, rising by £25 a year to £400 a year, together with temporary additions, making the total remuneration at present from £573 a year to £727 a year. These amounts may however be increased or reduced according to the cost of living.

Candidates should not be more than 45 years of age, and should have had experience in the supervision of the usual shop processes connected with the overhaul and renovation of electric tramway cars, motor lorries and other vehicles, the manufacture under modern production methods of renewal parts, etc., and the proper maintenance of the plant and tools used in connection therewith.

Applications must be on the appropriate official form, which specifies the conditions upon which the appointment will be held.

Forms may be obtained from the Clerk of the Council, County Hall, Spring Gardens, S.W. 1, and must be returned to the County Hall, not later than 4 p.m. on 2nd December, 1920. An addressed foolscap envelope bearing 2d. stamp must be sent with the request for a form of application.

James Bird,
Clerk of the London County Council.
K 747

CORPORATION OF CALCUTTA.

CIVIL ENGINEER—WANTED.

The Corporation of Calcutta require the

Services of a Properly

qualified CIVIL ENGINEER. He will be under the direction of the Chief Engineer and will be required to devote his whole time to his duties and will not be allowed to take up any private work. His duties will consist mainly in inspecting and reporting on the Improvement Works carried out by the Calcutta Improvement Trust while these works are in progress and before they are taken over for maintenance by the Corporation of Calcutta. He will be required to reside in Calcutta.

The appointment is subject to the Provident Fund, leave and other service rules of the Corporation and may be terminated at any time by 6-months' notice on either side. The Provident Fund contribution is 6¼ per cent. of the monthly salary and an equivalent amount is contributed by the Corporation and the fund accumulates at compound interest. The selected candidate will be required to submit to a medical examination before joining his appointment. He will be required to take up his duties within two months of the date of receiving notice of appointment.

B. The salary of the appointment is fixed at Rs. 1,000 per month. The person appointed will be required to keep a motor car, for the upkeep of which an allowance of Rs. 100 per month will be made. There are no other allowances. The cost of the motor car will, if desired, be advanced by the Corporation and recovered in monthly instalments spread over a period of not more than three years.

C. Preference will be given to candidates who are Corporate Members of the Institution of Civil Engineers or Graduates in Engineering of a University and have had experience of Construction of General Municipal Engineering and City Improvement Works particularly in regard to Water and Drainage Works and Modern methods of Road Construction.

D. Applications should be accompanied by copies of recent testimonials and a medical certificate of fitness for service in India. Candidates should state age and whether married or single.

E. The Corporation will pay 1st class passage from London to Calcutta but the amount so paid will require to be refunded if the person appointed leaves the service of the Corporation within two years of the date of joining his appointment. Half pay will be paid for the period occupied by the journey to Calcutta.

F. Applications will be received in the United Kingdom up to the 1st December, 1920, by W. C. Baston, Esq., B.Sc., M.Inst.C.E., 140, West George Street, Glasgow, from whom any further information may be obtained.

J. C. Mukherjea,
Secretary to the Corporation.
Central Municipal Office,
Calcutta, the 13th October, 1920. K 690

INVOLUTE TEETH.

By Richard Gardner.

Arc of Contact.—In Fig. 1, let S Q be the pitch circle of the wheel centred at O, M N the base circle, S the pitch point, P the point of the tooth P Q, and let P M, Q N be tangents to the base circle. Draw radii O S, O Q to cut the base circle in *s*, *q*.

Pitch circle radius O Q = R.
Addendum O P − O Q = H.
Arc S Q = A.
Obliquity = angle S O M = angle Q O N = ϕ.
Evidently S P = M N = *s q* = S Q cos ϕ = A cos ϕ.

Hence, considering the triangle O S P,

$$(R + H)^2 = R^2 + 2\,R\,A\cos\phi\sin\phi + A^2\cos^2\phi,$$

whence—

$$A\cos\phi = -R\sin\phi + [(R + H)^2 - (R\cos\phi)^2]^{\frac{1}{2}}$$

or

$$\frac{A}{R} = \frac{1 + \frac{H}{R}}{\cos\phi}\left[1 - \left(\frac{\cos\phi}{1 + \frac{H}{R}}\right)^2\right]^{\frac{1}{2}} - \tan\phi$$

which may be most simply written—

$$\frac{A}{R} = \frac{\sqrt{1 - x^2}}{x} - \tan\phi$$

$$\text{where } x = \frac{\cos\phi}{1 + \frac{H}{R}}$$

If the wheel under consideration is driven, then A is arc of approach; if the driver, then A is arc of recess.

Solving for H:

$$(R + H)^2 = (R\sin\phi + A\cos\phi)^2 + R^2\cos^2\phi$$

whence—

$$\frac{H}{R} = \left[\left(\sin\phi + \frac{A}{R}\cos\phi\right)^2 + \cos^2\phi\right]^{\frac{1}{2}} - 1.$$

A wheel which is large compared with its pinion may be treated as a rack. H is then the limit of

$$R\left[\left(\sin\phi + \frac{A}{R}\cos\phi\right)^2 + \cos^2\phi\right]^{\frac{1}{2}} - R,$$

when R is infinity. The expression

$$= R\left[\sin^2\phi\left(1 + \frac{A}{R}\cot\phi\right)^2 + \cos^2\phi\right]^{\frac{1}{2}} - R$$

$$= R\left[1 + 2\frac{A}{R}\cos\phi\sin\phi\right]^{\frac{1}{2}} - R$$

$$\left(\text{since } \left(\frac{A}{R}\right)^2 \text{ can be neglected}\right)$$

$$= R\left[\frac{A}{R}\cos\phi\sin\phi\right]$$

$$= A\cos\phi\sin\phi.$$

Let K denote the working flank for the tooth of a pinion gearing with a large wheel, or K is the depth of the earliest point of contact below the pitch circle of the pinion.

$$(R - K)^2 = (R\sin\phi - A\cos\phi)^2 + R^2\cos^2\phi$$

or—

$$\frac{K}{R} = 1 - \left[\left(\sin\phi - \frac{A}{R}\cos\phi\right)^2 + \cos^2\phi\right]^{\frac{1}{2}}.$$

We have found—

$$A = \frac{H}{\cos\phi\sin\phi}.$$

H being the addendum of the driven wheel. Therefore

$$\frac{K}{R} = 1 - \left[\left(\sin\phi - \frac{H}{R\sin\phi}\right)^2 + \cos^2\phi\right]^{\frac{1}{2}}$$

Now the point of contact cannot be within the base circle—that is, R—K must be greater than R cos ϕ, or

$$1 - \frac{K}{R} > \cos\phi$$

We thus have the relation between R and H—

$$\left[\left(\sin\phi - \frac{H}{R\sin\phi}\right)^2 + \cos^2\phi\right]^{\frac{1}{2}} > \cos\phi$$

or

$$R > \frac{H}{\sin^2\phi}$$

With machine-cut teeth of ordinary proportions, diametral pitch =

$$\frac{N}{2R} = \frac{1}{H} \text{ where N is No. of teeth in pinion,}$$

so that—

$$N > \frac{2}{\sin^2\phi}$$

For example, when ϕ = 15 deg., N cannot be less than 30 for standard teeth. If there are less than 30 teeth in the pinion, the addenda of the wheel teeth must be shortened, the pinion addenda being lengthened to correspond.

When H ÷ R is not so small that the gear may be treated as a rack, a simple approximate expression may be found for A ÷ R.

A ÷ R plotted against H ÷ R does not give a straight line, but $\log\frac{A}{R}$ against $\log\frac{H}{R}$ does. We thus find

$$\frac{A}{R} = 1{\cdot}7\left(\frac{H}{R}\right)^{\frac{1}{2}} \text{ for } \phi = 15°$$

$$\frac{A}{R} = 1{\cdot}65\left(\frac{H}{R}\right)^{\frac{1}{2}} \text{ for } \phi = 20°$$

These are handy expressions for purposes of

Fig. 1.

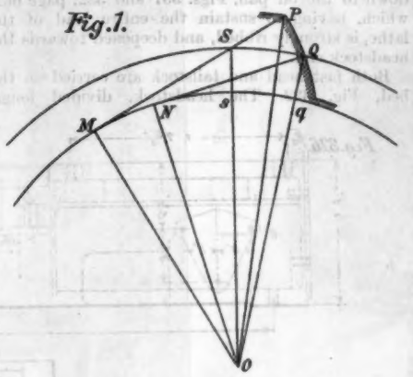
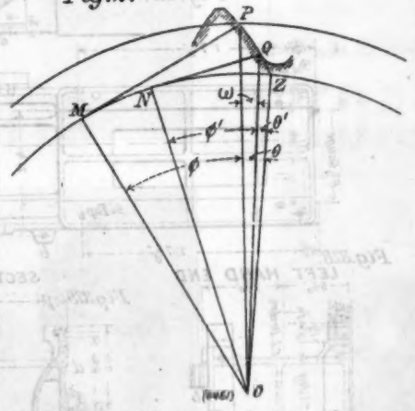


Fig. 2.



calculation or analysis. For instance, the average height of the point of contact above the pitch circle is

$$\frac{1}{A}\int_0^A h\,.\,da$$

during approach, and

$$\frac{a}{H} = 1{\cdot}7\left(\frac{h}{R}\right)^{\frac{1}{2}}$$

taking ϕ = 15 deg. Whence, average height = $\frac{4}{9}$ H.

If S denote arc of contact and P circumferential pitch, then the average number of teeth in the arc of action is S ÷ P, and if the teeth are cut with sufficient accuracy, S ÷ P is the average number of teeth always in contact. But the load is not equally distributed among this number of teeth, because of the variation in flexibility between an end of the arc of action and the pitch point.

Root Thickness.—This is taken as the thickness at the point where the involute flank joins the root fillet. In Fig. 2, let P be a pitch point and Q a root point on the tooth flank P Q, and let the involute P Q meet the base circle M N in Z. P M, Q N are tangents to the base circle. ϕ, θ, ϕ', θ', ω are the angles subtended at the centre O by M P, P Z, N Q, Q Z, P Q respectively.

Thickness on pitch circle = T.
Root thickness = X.
Dedendum O P—O Q = U.

Then the angle subtended at the centre by the root thickness is

$$\frac{X}{R - U} = \frac{T}{R} + 2\omega$$

From the nature of an involute, $\phi + \theta = \tan\phi$ and $\phi' + \theta' = \tan\phi'$, also $\omega = \Theta - \theta'$, therefore—

$$\frac{X}{R - U} = \frac{T}{R} + 2\,[(\tan\phi - \phi) - (\tan\phi' - \phi')], \text{ or}$$

$$\frac{X}{R} = 2\left(1 - \frac{U}{R}\right)\left[\frac{T}{2R} + (\tan\phi - \phi) - (\tan\phi' - \phi')\right]$$

$$\text{in which } \cos\phi' = \frac{R\cos\phi}{R - U} = \frac{\cos\phi}{1 - \frac{U}{R}}$$

and ϕ is obliquity of action. When U is as great as possible, as for a small pinion,

$$1 - \frac{U}{R} = \cos\phi,\ \phi' = 0,$$

$$\text{and } \frac{X}{R} = 2\cos\phi\left[\frac{T}{2R} + \tan\phi - \phi\right]$$

or, $X = T\cos\phi + 2R(\sin\phi - \phi\cos\phi)$

$= .483\,P + .0118\,R$ for $\phi = 15°$

$= .47\,P + .0277\,R$ for $\phi = 20°$

P being the circumferential pitch.

When U ÷ R is small, we can conveniently find the limit of X by means of Gregory's series—

$$\theta = \tan\theta - \frac{\tan^3\theta}{3} + \frac{\tan^5\theta}{5} - \ldots\ldots$$

Referring to the general expression for X ÷ R,

$$\tan\phi - \phi = \frac{\tan^3\phi}{3} - \frac{\tan^5\phi}{5} + \ldots\ldots$$

$$\tan\phi' = (\sec^2\phi' - 1)^{\frac{1}{2}}$$

$$= \left[\left(1 - \frac{U}{R}\right)^2\sec^2\phi - 1\right]^{\frac{1}{2}}$$

$$= \left[\left(1 - \frac{U}{R}\right)^2(1 + \tan^2\phi) - 1\right]^{\frac{1}{2}}$$

$$= \left[\tan^2\phi - 2\frac{U}{R}(1 + \tan^2\phi)\right]^{\frac{1}{2}}$$

(neglecting the square of U ÷ R)

$$= \tan\phi\left[1 - 2\frac{U}{R}\left(\frac{1}{\tan^2\phi} + 1\right)\right]^{\frac{1}{2}}$$

$$\tan\phi' - \phi' = \frac{\tan^3\phi}{3}\left[1 - 2\frac{U}{R}\left(\frac{1}{\tan^2\phi} + 1\right)\right]^{\frac{3}{2}}$$

$$- \frac{\tan^5\phi}{5}\left[1 - 2\frac{U}{R}\left(\frac{1}{\tan^2\phi} + 1\right)\right]^{\frac{5}{2}}$$

$$+ \ldots\ldots\ldots\ldots$$

$$= \frac{\tan^3\phi}{3}\left[1 - 3\frac{U}{R}\left(\frac{1}{\tan^2\phi} + 1\right) + \ldots\ldots\right]$$

$$- \frac{\tan^5\phi}{5}\left[1 - 5\frac{U}{R}\left(\frac{1}{\tan^2\phi} + 1\right) + \ldots\ldots\right]$$

$$+ \ldots\ldots\ldots\ldots$$

$$= \frac{\tan^3\phi}{3} - \frac{\tan^5\phi}{5} + \ldots\ldots$$

$$- \frac{U}{R}\left(\frac{1}{\tan^2\phi} + 1\right)(\tan^3\phi - \tan^5\phi + \ldots\ldots)$$

$$= \tan\phi - \phi - \frac{U}{R}\tan\phi$$

$$\text{Hence, } \frac{X}{R} = 2\left(1 - \frac{U}{R}\right)\left(\frac{T}{2R} + \frac{U}{R}\tan\phi\right)$$

$$\text{or } X = \left(1 - \frac{U}{R}\right)(T + 2U\tan\phi)$$

$$\text{and when } \frac{U}{R} = 0,$$

$$X = T + 2U\tan\phi$$

which is evidently the root thickness for a rack.

It appears that the root thickness of a large wheel tooth is obtained approximately by multiplying the root thickness of the corresponding rack tooth by $\left(1 - \frac{U}{R}\right)$ but it is preferable to graph $\frac{X}{P}$ against $\frac{U}{R}$, and thence find a linear equation, which can be done with close approximation, the curve being very flat. For Brown and Sharpe standard teeth,

$$U = \left(\frac{1}{\pi} + \frac{1}{20}\right)P,\ R = \frac{NP}{2\pi}$$

$$\frac{U}{R} = \frac{2 + 10}{N} = \frac{2{\cdot}314}{N}$$

$$\frac{T}{2R} = \frac{P}{4R} = \frac{\pi}{2N} = \frac{1{\cdot}57}{N}$$

so that $\frac{X}{F} =$

$$\frac{N}{\pi}\left(1-\frac{2\cdot314}{N}\right)\left[\frac{1\cdot57}{N}+(\tan\phi-\phi)-(\tan\phi'-\phi')\right]$$

and plotting $\frac{X}{F}$ against $\frac{1}{N}$, we find

$$\frac{X}{F} = \cdot70 - \frac{5\cdot9}{N} \text{ for } \phi = 15 \text{ deg.}$$

$$\frac{X}{F} = \cdot77 - \frac{4\cdot9}{N} \text{ for } \phi = 20 \text{ deg.}$$

This is for teeth with flanks completely involute—that is, $\cos\phi$ is not greater than $1-\frac{U}{R} = 1-\frac{2\cdot314}{N}$ or N is not less than $\frac{2\cdot314}{1-\cos\phi} = 68$ and 39 for 15 deg and 20 deg. respectively. Any other case, for instance when the dedendum is less than the standard, can be dealt with in similar manner.

RECENT MACHINE TOOL DEVELOPMENTS.—No. XVII.

By Joseph Horner.

As the turret lathe appropriated a very large volume of work from the common lathe, so now the automatic turning machines are making deep inroads on its province. The movement is one of the many phases of the specialisation that is dominating the shop practice of the present time. The automatic lathe is not exactly a single-purpose machine, but its operations are much more limited than those of the turret lathe. In some designs it includes a turret with its battery of varied tools, but this is not an essential equipment. To some, a magazine attachment is made, but this is not a necessary fitting. The principal function of the automatic turning machine in its several designs is that of simplifying operations, with reduction of costs. It does not follow that the machine design is of a more elementary character. On the contrary it frequently combines the mechanisms of the turret lathes and screw machines. But the point is, that the economies effected on it are greater than those on the other machines. And, generally its duties are of a more limited character. It is one among so many illustrations of carefully-thought-out elaboration of design directed to the performance of very elementary operations.

One of the later automatic turning machines is the subject of the present article. The Fay automatic lathe, built by the Jones and Lamson Company, of Springfield, Vermont, U.S.A., is a "second operation" machine. The turret lathe occupies the secondary role of its satellite, supplying it with those articles that have to be carried directly between centres, or put on arbors, supported on centres. This performance of second operations of turning, and facing, straight and tapered, with multiple tools, and forming, after a piece has been bored in a lathe or drilling machine, is in extensive and growing use. The results are more nearly accurate than when turning and boring are done at the same chucking in one machine. The setting-up of tools is simplified. Pieces that have been roughed-out elsewhere can be brought to the automatic lathe to be finished. Equipped with batteries of simple single-edged cutting tools, rigidly supported, and with suitably regulated speeds, and feeds, the output is very large on repetitive products. The exclusion of face chucks, and of arrangements for cutting screw threads concentrates design on the work done between centres.

The Fay lathe is built in three styles, shown by the views, Figs. 322 to 325, on page 661. The usual design has two tool blocks, one at the front, Fig. 322, and one at the back, Fig 323, which gives a rear view of the machine. Another has two blocks at the front, Fig. 324, and one at the rear. A third, Fig. 325, is a design modified for the special work of turning the blanks for bevel gears. The general aspect of the ordinary machine may be gathered from a study of the front and rear views in Figs. 322 and 323 respectively. It resembles the common lathe in possessing a bed, headstock and tailstock. It differs from the lathe in almost all the details of its construction.

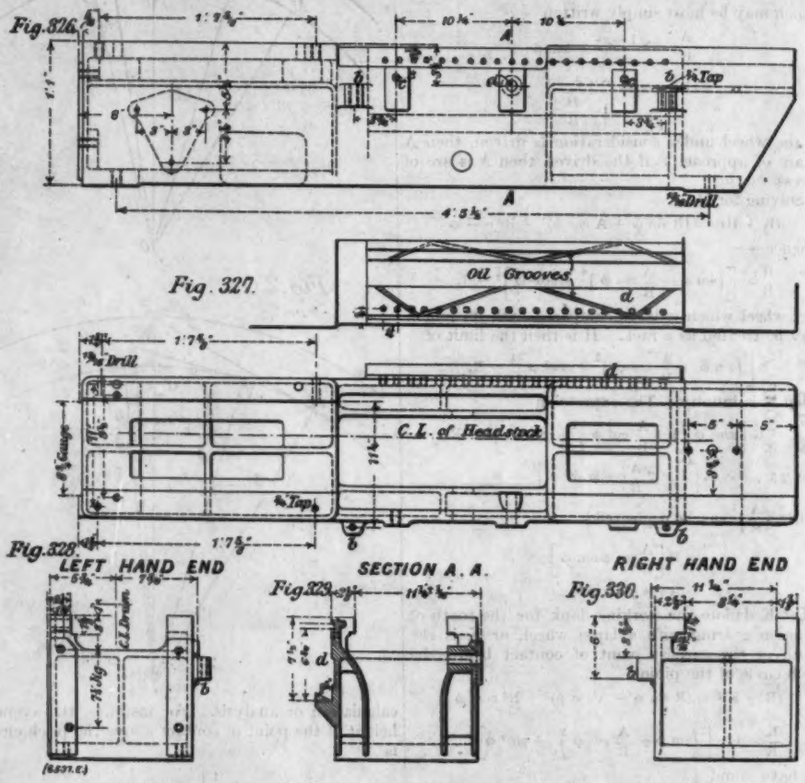
The bed, seen in various views in Figs. 326 to 330, receives the head, and tailstocks. It is of box-section, and doubly ribbed over the area where the cutting pressures come. The former slide, an essential element of these lathes, is attached to the front of the bed. Compare with Fig. 322. The slide is mounted on a way or guide that is pivoted about the stud *a*, Fig. 326, and may be tipped from the horizontal to slight angular positions around the stud in either direction, by the tightening of setting screws on the lugs *b*, *b*. After setting, it is clamped with screws at *c*, *c*. Reference to the work of this guide, and its slide, will be made later. On the other side of the bed the back tool carriage is actuated through the movements of a bar transmitted to a slide, reciprocated over the faced portion *d*—compare Figs. 327 and 329, provided with zig-zag oil grooves, and having one vee'd recess in which the slide takes a bearing. The bed is bolted down to the oil pan, Figs. 331 and 332, page 662, which, having to sustain the entire load of the lathe, is strongly ribbed, and deepened towards the headstock end.

Both fast head and tailstock are carried on the bed, Fig. 322. The headstock, divided longitudinally, is of all-geared design. The spindle, shown in Fig. 333, is of cast-iron, with long and large journals, which qualify it to withstand the heavy duty imposed on it. The nose receives an equalising double driver face plate, Figs. 322 to 324. The geared head is shown in Fig. 334, page 663, and in the front elevation of the lathe, Fig. 335. Fig. 336 is an end view from the headstock end, Fig. 337 a rear view at the same end, Fig. 388 is the development of the cam drum, and Fig. 339 is a section of the cross slide.

The spindle is driven primarily by the pulley A, running at a constant speed, or by fast and loose pulleys. The pulley shaft carries a triple sliding gear B, moved by hand to mesh with the three gears on the intermediate shaft C. These drive to the pinion D that meshes with the large wheel H on the spindle. Automatic speed changes are produced, first by E, a clutch gear, which effects a medium-speed change, second by F, a clutch gear for the fast-speed change. G is the collar for operating these clutches. H gives a slow-speed drive through a silent ratchet, which acts only when clutch gears E and F are disengaged. J is a constant-speed fast-feed motion pulley, and *f* is the first gear in the train for the slow-feed motion.

The speed gears give three groups of three speeds each, or nine speeds in all. The machine can be changed from one group to another by hand when it is being set up. When so set, cam and lever connections provide for the selection of any one of the three speeds in each group. The objection to delays in changing to suitable speeds is thus removed. While some pieces of work can be done at one speed, others require two or three. When only two speeds are required, there is a choice of three ratios—that between E and F is about as 1 : 1·5, that between H and E as 1 : 2·4, and that between H and F as 1 : 3·7.

The transmission gears and shafts are of hardened steel, ground in the bearings. They run in oil which is thrown up by the large spindle gear H. This returns through the spindle journal, and the thrust bearing to the lower reservoir in the headstock casting, so providing continuous circulation. The clutches for the gears E and F are of the multiple disc design, Fig. 334, giving a firm grip, with light pressure, and wear is slight.



The tailstock is bolted directly to the bed, and is of a common design, without set-over for taper turning. The latter is done with a former acting on the tool carriage, and short tapers can be turned from a compound rest.

The fitting of the tool carriages at front and rear presents unique features. They do not rest on the bed, but are carried and clamped on heavy round steel bars. The centre bar for the front carriage is seen in the photograph, Fig. 322, and at L, Figs. 335 and 336. The bar goes through holes in both head and tailstocks, so tying these rigidly. A pivoted supporting shoe at the front end of the carriage rests on a hardened former M, mounted on the former slide N, Fig. 335, the function of which is that of guiding the point of a tool when tapered, or curved surfaces have to be turned. The carriage is provided with a large number of set-screws for multiple tooling. The feed motions are derived through the bar from cams on the inner surface of the cam drum at the headstock end of the machine.

The action of the former plate is as follows: As the carriage is fed forward, the shoe on which its outer end is supported follows the contour of the former M, rocking the carriage about the bar, and

THE FAY AUTOMATIC LATHE.

CONSTRUCTED BY THE JONES AND LAMSON COMPANY, SPRINGFIELD, VERMONT, U.S.A.

(For Description, see opposite Page.)

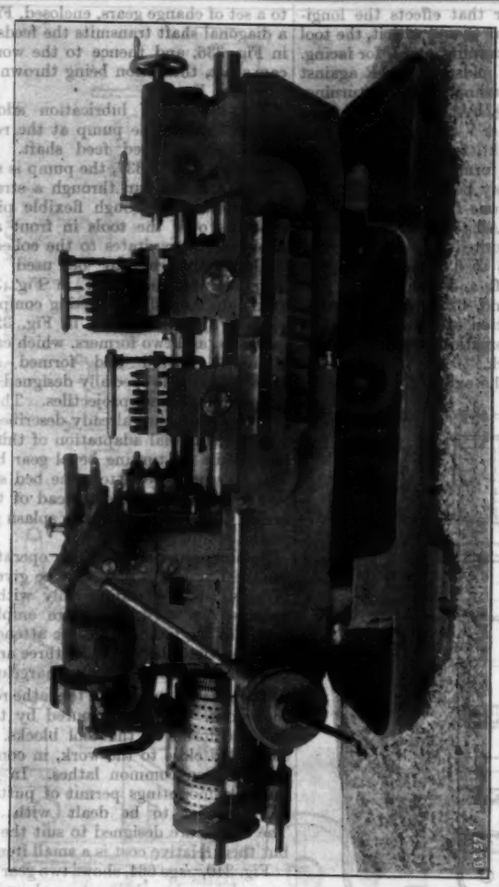


FIG. 324.

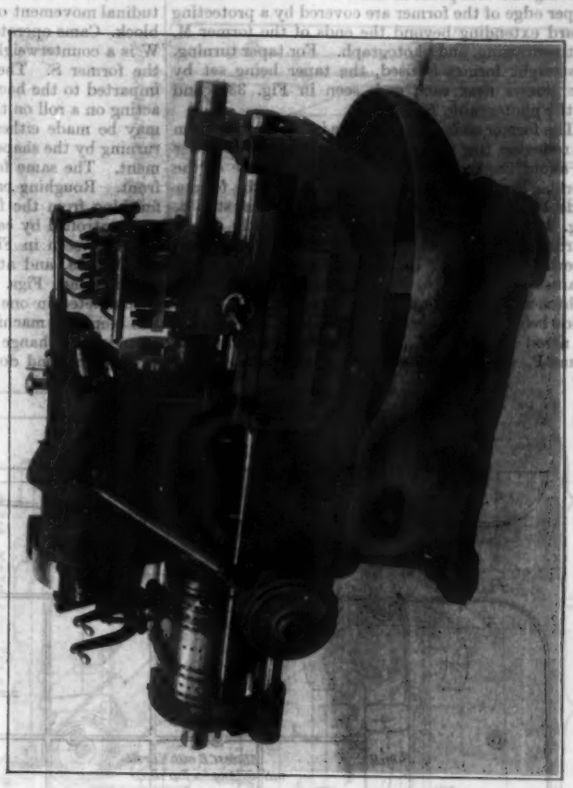


FIG. 325.

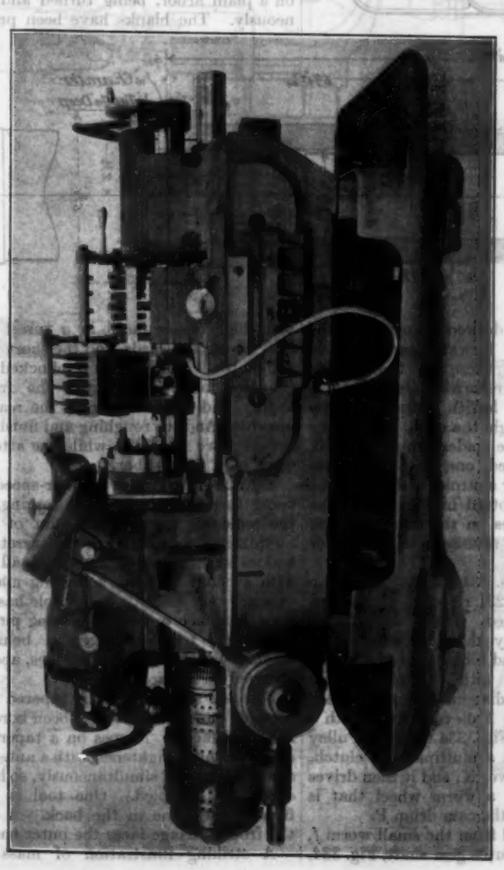


FIG. 322.

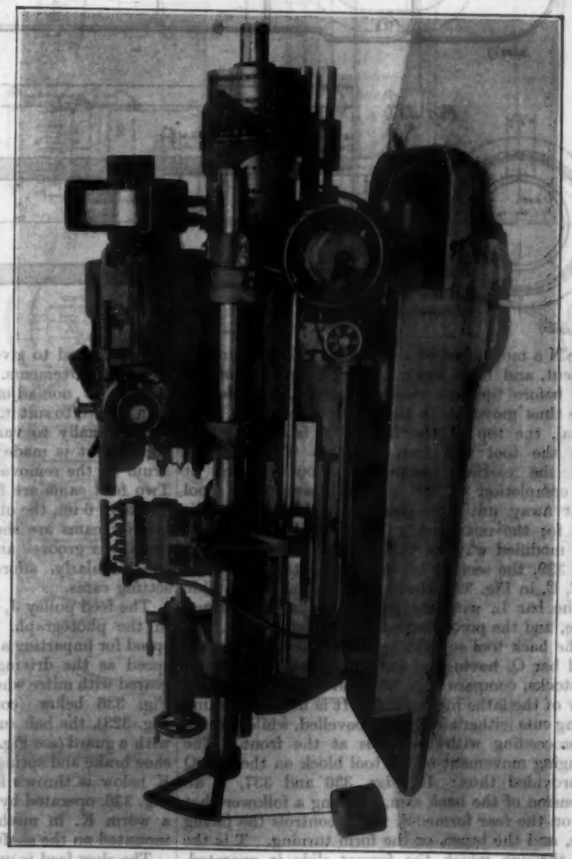


FIG. 323.

moving the tool point in unison. The shoe and the upper edge of the former are covered by a protecting guard extending beyond the ends of the former M, in the drawing, and photograph. For taper turning, a straight former is used, the taper being set by the screws near each end, seen in Fig. 335, and in the photograph, Fig. 332.

The former slide also fulfils the important function of relieving the tool on the return stroke in order to avoid the scoring of the finished surface of the work. The guide N, Fig. 335, on which the former slide M is mounted, is pivoted on a central stud *a*, Fig. 327, on which it can be tipped slightly downwards at either end by the control of the grub screws seen dotted in Fig. 335, next the ends, against the lugs *b*, *b*, Fig. 327. The slide is then tightened with the screws *c*, *c*, from the front. The guide being thus tipped, the former slide is connected by a rod O, Fig. 335, with relieving cams on the drum P, which cams are set to give the former slide N a movement of about $\frac{1}{4}$ in. before beginning the cut, and back again at the completion of the cut, before the tool starts to return. While the slide thus moves at a slight angle from the horizontal, the top of the former M is set level, so that the tool will turn straight. The result is that the carriage drops by about $\frac{1}{64}$ in. at the completion of the cut, so drawing the tool point away until the carriage returns in readiness for the next cut. The method is employed in a modified way for the relief of curved cutting. Fig. 339, the section taken through the cross-slide at C, C, in Fig. 335, shows the relation of the slide to the bar L, with the guiding ways, the formed plate, and the pivoted shoe already referred to.

The back tool support is also carried on a heavy steel bar Q, having its anchorage in the head and tailstocks, compare Figs. 336 and 337 with the rear view of the lathe in Fig. 323. It is used for taking facing cuts, either straight, or bevelled, while turning is proceeding with the tools at the front. The swinging movement of the tool block on the bar Q is provided thus: R, Figs. 336 and 337, is an extension of the back arm, carrying a follower that lies on the rear former S, which controls the facing cuts, and the taper, or the form turning. T is the rod through which the former slide is operated, U is a cam roll slide, controlling the motions of T, and V, is a cam roll carrier that effects the longitudinal movement of the bar Q, and with it, the tool block. Cams operate V for turning, and U for facing. W is a counterweight that holds the arm R against the former S. The longitudinal feed for turning, imparted to the back bar Q, by the control of cams acting on a roll on the carrier V clamped to the bar, may be made either straight, tapered, or for form turning by the shape of the former S, and its adjustment. The same forms may be used on back and front. Roughing can be done from the back, and finishing from the front. All the feed movements are controlled by cams mounted on, or within, the drum P, seen in Figs. 335 to 337, and developed in Fig. 338, and at the left and right of the two photographs, Figs. 322 and 323. An operation is completed in one revolution of the drum, which also stops the machine automatically, ready for the attendant to change the work.

The cams and dogs on the exterior of the drum can be timed to give any desired sequence to the various movements. The forward cam on the interior is non-adjustable, those on the outside being timed to suit it. The return cam is adjustable longitudinally to vary the length of stroke. The adjustment is made through the open end of the drum on the removal of the spider arms, Fig. 336. Two feed cams are furnished, one for a maximum stroke of 6 in., the other for a stroke of 10 in. The interior cams are shown dotted in Fig. 338. The numerous grooves and holes on the outside which run circularly, afford the necessary facilities for setting cams.

The feed pulley J, in Figs. 334 and 337, seen also in the photograph, Fig. 323, runs at a constant speed for imparting a fast feed. It runs at the same speed as the driving pulley shaft, to which it is geared with mitre wheels, and is belted to a pulley K, Fig. 336 below (compare with the photograph, Fig. 323), the belt running diagonally, and enclosed with a guard (see Fig. 337). Pulley J is fitted with a shoe brake and spring rod, Figs. 334 to 337. Pulley K below is thrown in with a multiple disc clutch, Fig. 336, operated by the lever X, and it then drives a worm K, in mesh with a worm wheel that is mounted on the shaft L of the cam drum P.

The slow-feed is operated from the small worm *f*, driven by mitres from the clutch gear shaft, Fig. 334, to a set of change gears, enclosed, Fig. 335. Thence a diagonal shaft transmits the feeds to the worm K in Fig. 336, and thence to the worm wheel on the cam shaft, the action being thrown in and out with the lever X.

The system of lubrication adopted is ample. Fig. 323 shows the pump at the rear, belted from the constant speed feed shaft. Comparing this with Figs. 335 to 337, the pump is seen to draw the liquid from the pan through a strainer Y, whence it is delivered through flexible pipes to the distributors over the tools in front and back posts. After use it gravitates to the collecting pan, going through strainers, to be used again. Guards seen at front and back in Fig. 336 protect the attendant from flying cutting compound and chips.

The Fay lathe shown in Fig. 324 has two tool carriages, and two formers, which can be set to turn straight, tapered and formed surfaces simultaneously. It is specially designed for dealing with long forgings and projectiles. The mechanism is identical with that already described.

A more special adaptation of this machine is the lathe built for turning bevel gear blanks, Fig. 325. The tailstock is omitted, the bed shortened, and a compound rest is used instead of the regular beck arm. It is surrounded with splash guards, removed in the photograph.

Some particulars of the operations performed on the Fay lathes may now be given. The output is very large. Dealing only with work between centres, two work arbors are employed, one being in use in the lathe, while the attendant is changing work on the other. Using three arbors, it is often possible for one man to take charge of two machines.

The great economies of the lathe relate to multiple tool work, which is favoured by the rigid design, and the forms of the tool blocks. The tools are supported close to the work, in contrast with their overhang on common lathes. In many cases the multiple mountings permit of putting two articles on an arbor to be dealt with simultaneously. The arbors are designed to suit the work in hand, but their relative cost is a small item.

Fig. 340, page 664, shows two gear blanks mounted on a plain arbor, being turned and faced simultaneously. The blanks have been previously bored, and their bosses faced in a turret lathe, the long boss facing outwards, and the short boss faced with a hook tool. Being then re-chucked by their bores, the rims are turned from the front carriage—sliding, and their faces from the rear carriage—fed inwards. And the roughing and finishing are divided between two machines, while the attendant changes work on a third arbor.

Fig. 341 illustrates a four-speed cluster gear, being turned from a rough forging, which entails the removal of a large amount of material. The forging has been bored in the turret lathe, and has had its large end faced, and the small end squared up with a counterbore in a drilling machine. As the cuts are very heavy, a small hole has been drilled in the larger face to carry a driving pin, to avoid slip. The front tools turn, those behind face. One machine roughs, another finishes, and work is being changed on a third arbor.

Fig. 342 shows a doubly tapered coupling bush, used for line shafts. It has been bored, and one end has been faced. It goes on a tapered arbor with a split bushing, tightened with a nut. The two tapers are being turned simultaneously, so halving the time ordinarily occupied. One tool is carried on the front holder, one in the back. A second tool on the front carriage faces the outer end.

A striking illustration of mass production is

Fig. 331.

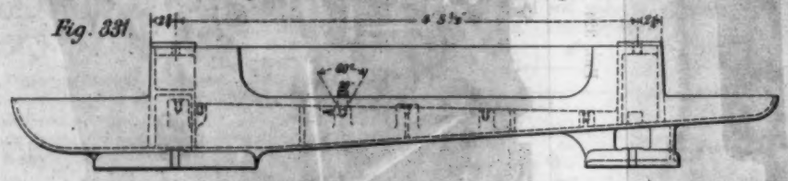



Fig. 332.

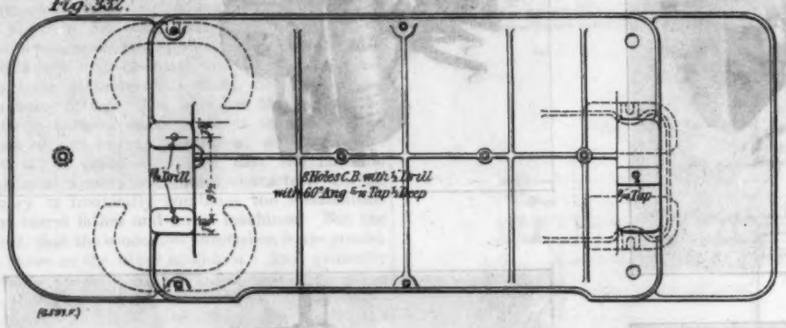
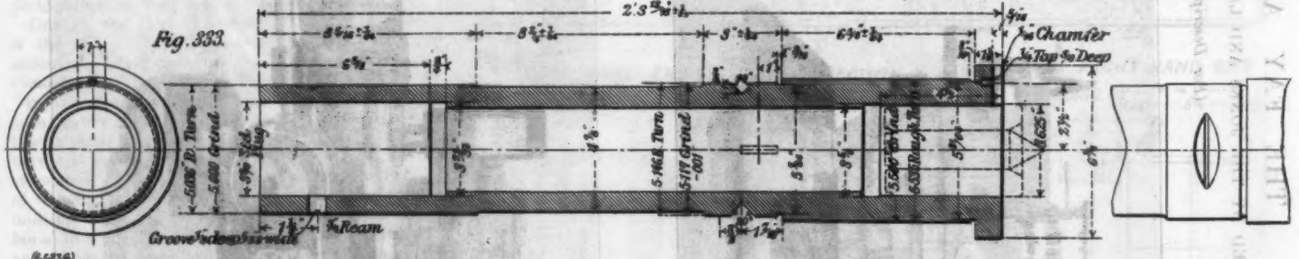


Fig. 333.



RECENT MACHINE TOOL DEVELOPMENTS; THE FAY AUTOMATIC LATHE.

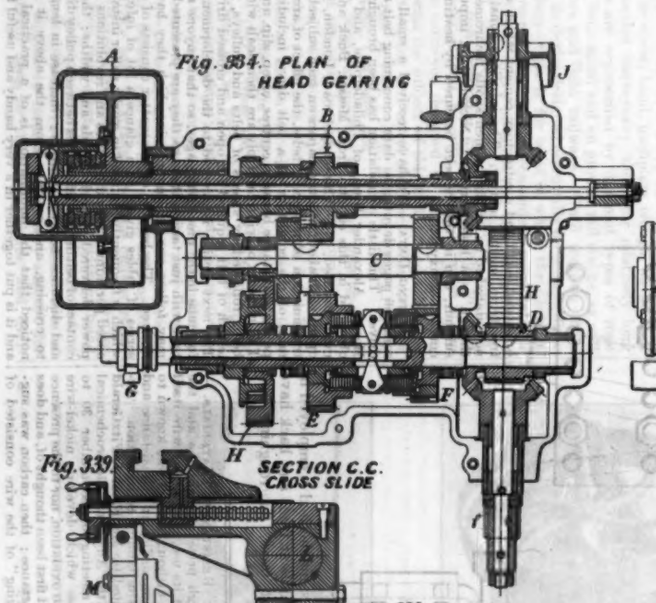


Fig. 334. PLAN OF HEAD GEARING

Fig. 339. SECTION C.C. CROSS SLIDE

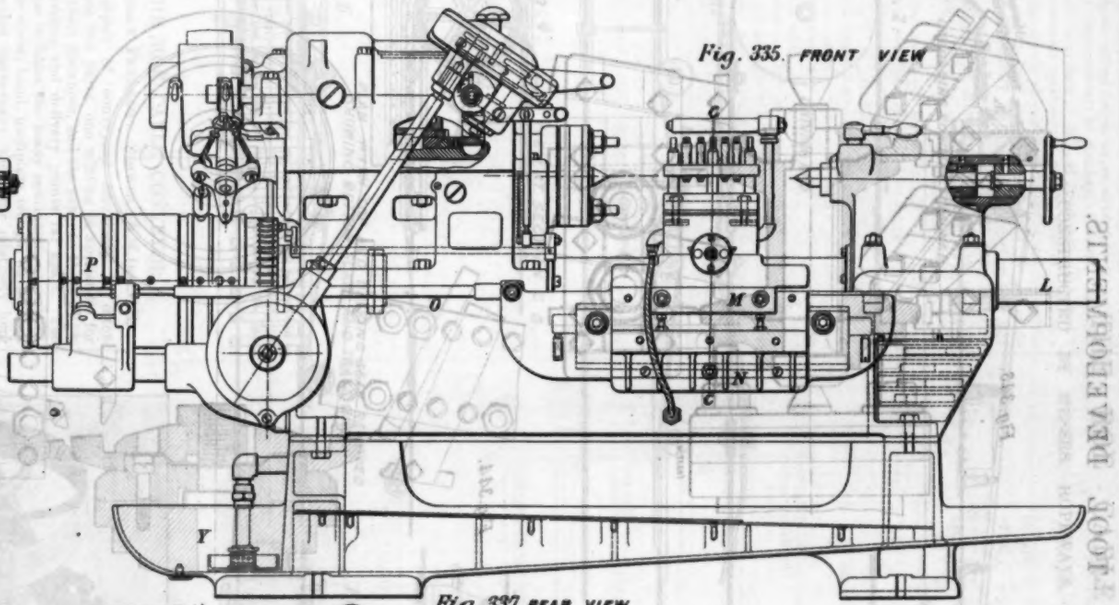


Fig. 335. FRONT VIEW

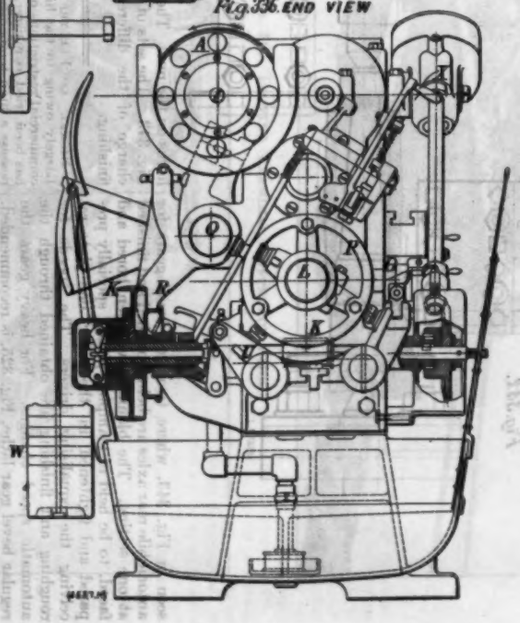


Fig. 336. END VIEW

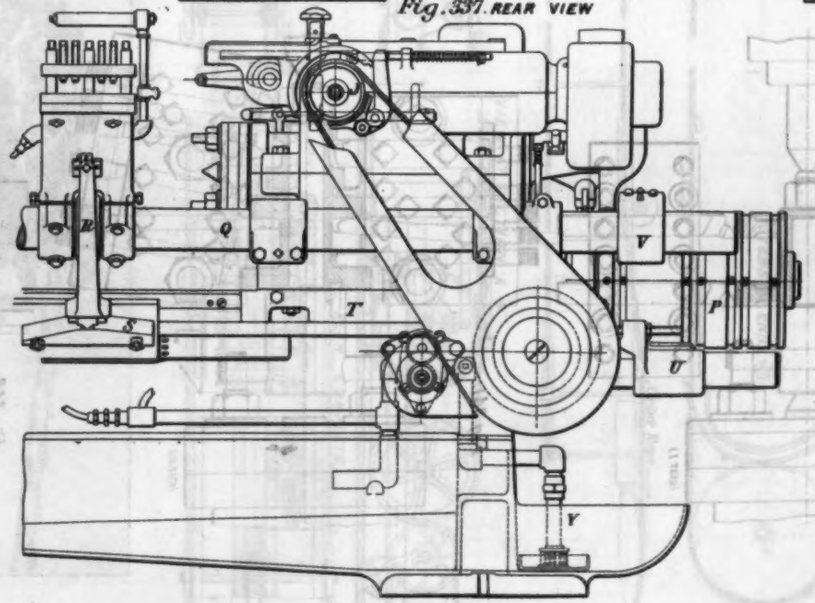


Fig. 337. REAR VIEW

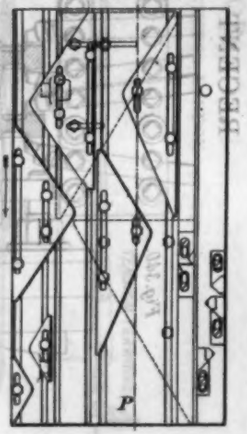
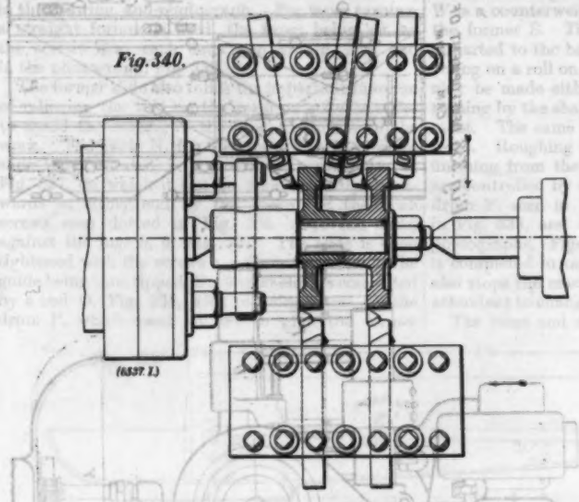
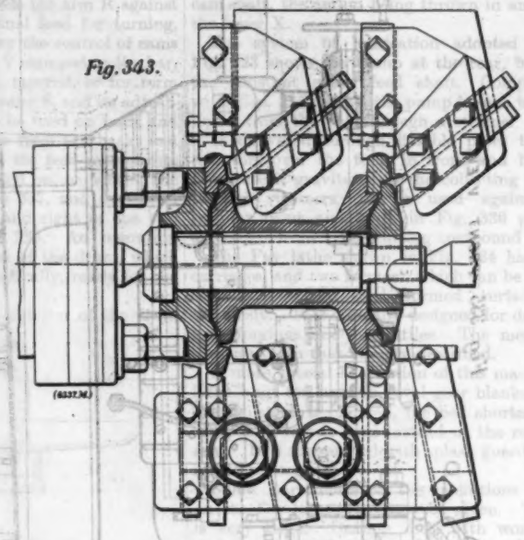
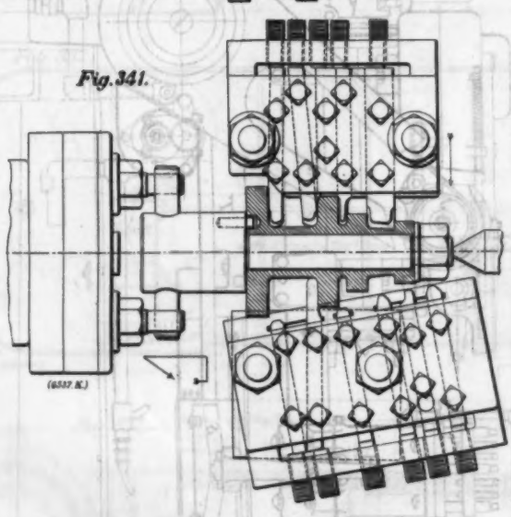


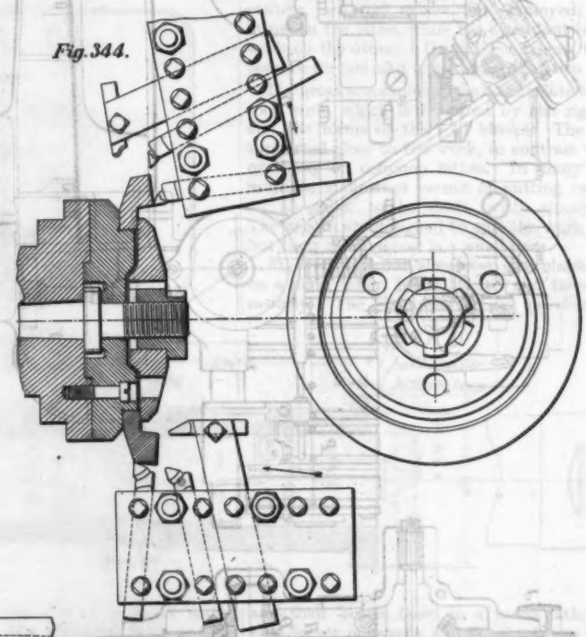
Fig. 338. DEVELOPMENT OF CAM DRUM

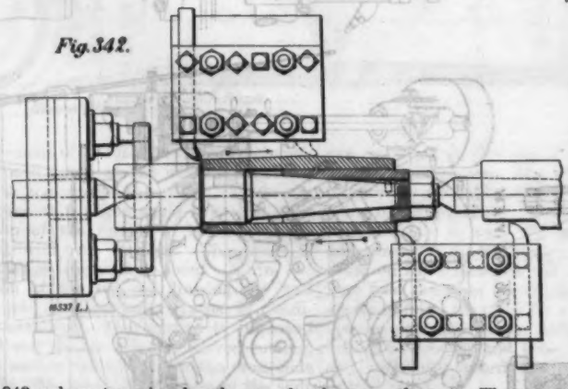
RECENT MACHINE TOOL DEVELOPMENTS.











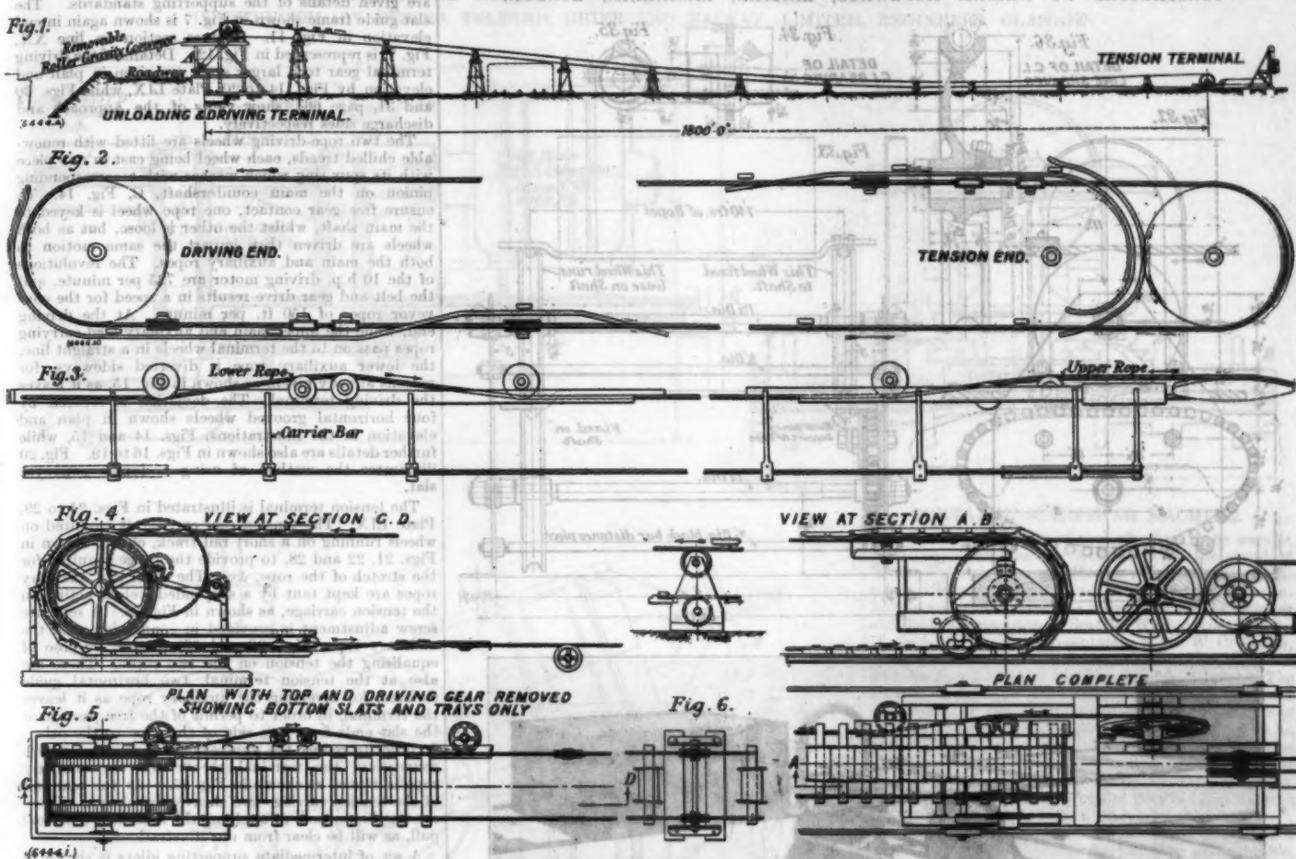
seen in Fig. 343, where two ring bevel gears for automobile rear axles are being roughed and finished at one setting. The blanks have been bored and faced, to be held in clamping pieces, specially prepared and tightened in the arbor, one plate receiving the equalising drivers. The speeds for roughing and finishing are obtained through the automatic speed changes. For heavy gears the regular bevel gear lathe, Fig. 325, is recommended. A rig-up on this machine is illustrated in Fig. 344. The blank has been bored, and faced at back and front in a turret lathe. Special face and clamping plates are made, tightened with the triangular nut, which is not run off when changing work, but merely slackened to permit of turning the clamp plate partly round to bring its slot holes in line with the horns on the nut. The same method is employed in Fig. 343. The sets of tools at front and back have charge of the different faces, for roughing and finishing.

NICKEL AS ELECTRIC RESISTANCE MATERIALS.—Largely owing to the high price of nichrome and the commercial restrictions of its use, pure nickel wire itself has been tried as resister, although nickel was known to possess a high temperature coefficient of resistance and was credited with a certain liability to oxidation. According to a paper presented by Mr. F. A. J. FitzGerald and Mr. G. C. Moyer to the American Electrochemical Society, at the annual meeting of September 30 to October 2, the brittleness which develops nickel-wire resistances is due neither to oxidation, nor to the presence of carbon. Oxidation had first been thought of, and does occur, but is not of importance; then carbon was suggested because the "lagging" of the wire consisted of infusorial earth and a refractory cement which were not free from organic matter. The injurious constituent is now stated to be sulphur, which spoils nichrome as well, though to a lesser extent. Nickel wire, impure with sulphur, can in this respect be cured by heating it in a current of oxygen.

BELTING DATA.—We have received a small book of some 56 pages devoted to data concerning belt and belt drives. This little compilation has been brought out by Messrs. Alexander Bros., of Philadelphia, and may be obtained in this country from Messrs. Buck and Hickman, Limited, 2-4, Whitechapel-road, London, E.1. It opens with about a dozen papers on such subjects as the transmission of power by belts, the effect of arc of contact, of the condition of a belt drive, including such points as distance between centres, creep, slip, and so on. The subjects of width and ply are then dealt with, these being followed by speeds of belts and pulleys, data on length of belt required for open and crossed drives, &c. The next section is devoted to the development of the formulæ in the preceding pages, so that anyone not content with just taking these as they are presented to him may follow out the manner in which they have been derived. The balance of the matter consists of a useful series of tables giving at a glance a lot of information which is frequently required in works, as for instance belt speed per minute for pulley sizes and revolutions; horse-power delivered for belt speeds and widths; the arc of contact of belting for differences between pulley diameters and distance between centres; increase in length due to crossing, and so on. From the above it will be noticed that the information is of a practical nature, and it is put together in a very handy and useful form.

THE ROE CABLE CONVEYOR.

CONSTRUCTED BY MESSRS. ROPEWAYS, LIMITED, ENGINEERS, LONDON.



THE ROE CABLE CONVEYOR.

By George Frederick Zimmer, A.M.Inst.C.E.

The subject of conveying machinery is often divided into two parts, one relating to appliances for relatively short distances, and the other to those which connect feeding and delivery points far apart. The former type includes the many continuous conveyors, such as the screw, band, pushplate, trough, bucket and gravity-bucket conveyors; those for relatively long distances are represented by different types of rope haulage, both aerial and on ground rail tracks, as well as telphers and light railways. Until recently there has been no device designed essentially for intermediate propositions—that is for cases in which the distance to be covered exceeds the convenient range of the first-mentioned types of conveyor, though really too short for the advantageous adoption of ropeways, telphers, light railways, &c. An attempt to meet these conditions has, however, now been made in the wire rope conveyor designed by Mr. J. Pearce Roe, which forms the subject of this article, and embodies many interesting and novel features. This conveyor we illustrate in Figs. 1 to 37, given on Plate LIX, the present page, and page 666.

It may seem curious that the use of wire rope conveyors of the class having more than one rope, has hitherto been so restricted. The reason for this is, however, evident when it is remembered that it has been the practice to attach the ends of the slats or their mechanical equivalents to separate endless ropes, with the result that if these are not exactly of the same length, strains are set up in the connections which are fatal to proper working; indeed, failure is practically unavoidable since it is next to impossible to splice up separate endless ropes to exactly the same length. In the conveyor we are about to describe no such stresses can occur, because one end only of the slats or transverse carrier bars is attached to one endless rope; the unattached end merely rests upon, and derives support from, the other rope or ropes without being attached thereto. An arrangement of this nature makes it possible for two or more endless ropes of different lengths to form a satisfactory support for the conveyor slats or their equivalents, and over-

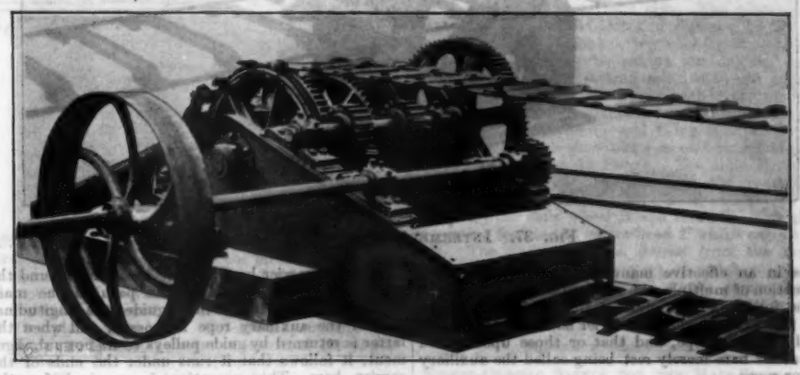


Fig. 30. Driving Terminal; Approach Side.

Fig. 31. Driving Terminal; Discharge Side.

THE ROE CABLE CONVEYOR.

CONSTRUCTED BY MESSRS. ROPEWAYS, LIMITED, ENGINEERS, LONDON.

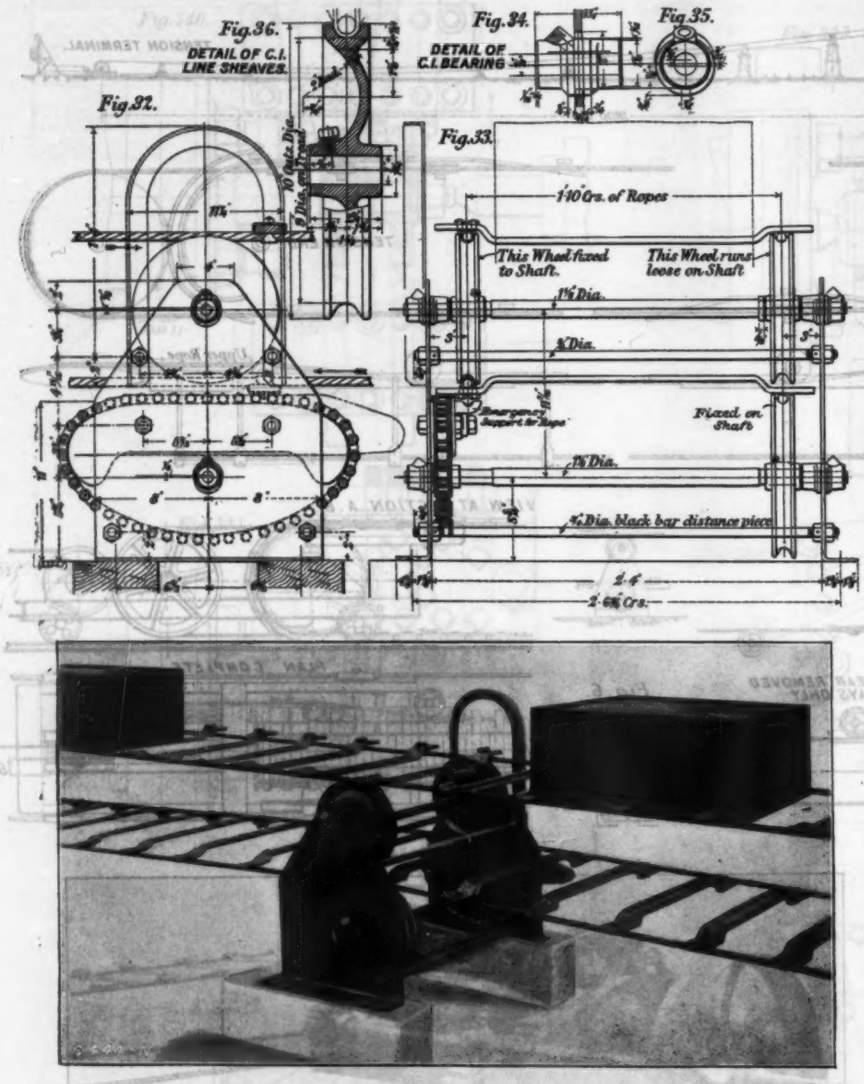


FIG. 37. INTERMEDIATE SUPPORT.

comes in an effective manner the objection to the application of multiple wire ropes to conveyor practice. In the following description of the Roe conveyor the rope to which the slats or carrier bars are attached, is called the main rope, and that or those upon which the carrier bars merely rest being called the auxiliary rope or ropes.

The general arrangement of the first conveyor of this kind, built for the military authorities, is shown in Fig. 1, page 665. Several variations are possible in the construction of this conveyor. There may be one main rope on one side of a conveyor and an auxiliary rope on the other, as in the case described, or there may be one central main rope with two auxiliary ropes, one on either side. In a conveyor with two endless ropes parallel and side by side, each working in its own vertical plane, the unattached ends of the carrier bars are supported on the outward run on the upper side of the upper auxiliary rope, and on the return on the top of the return portion of the auxiliary rope below. This requires the free or unattached ends of the carrier bars to be transferred at or near the terminal from the bottom to the top of the auxiliary rope and *vice versa*. The manner in which this is accomplished will be made clear by reference to Figs. 2 and 3, the former showing main and auxiliary ropes in plan, and the other the auxiliary rope and guides in elevation. The change over is effected by slightly deviating the auxiliary rope from its normal alignment near each terminal, in order to allow the free ends of the carrier bars to leave it and run round the guides which correspond to the path of the main rope. While moving in these guides the longitudinal axis of the auxiliary rope is crossed, and when the latter is returned by guide pulleys to its normal alignment, it follows that it runs under the ends of the carrier bars. This operation is required for the auxiliary rope at both terminals. The general wheel and sheave arrangement with the ropes and carrier bars is shown in Figs. 4, 5 and 6. The left hand ends of Figs. 4 and 5 show the driving terminal, while to the right hand end of each of these figures is shown the tension terminal. Fig. 6 is an intermediate support.

When a central main rope is employed to which the carrier bars are attached, in conjunction with an auxiliary rope at each side, the two loose ends of each carrier bar rest upon the auxiliary ropes and are changed over at each end by the method just described. In such a case, as both ends of the carrier bars would rest on the top of an auxiliary rope, they would be free to pass over ordinary supporting sheaves. There is then no need for special arrangements for supporting them, while the carrier bars themselves take the main or traction rope, and sheaves beneath that rope are not required.

In Fig. 7, Plate LIX, is given a sectional elevation of the driving terminal which is also the delivery end. This is on the line AA, Fig. 8, the latter showing a plan of the terminal. These drawings show the platform for the attendant and a portion of the delivery shoot, to which gravity roller extensions can be attached in a variety of directions, as shown by the small diagram Fig. 13. An end elevation of the terminal is given in Fig. 9. To the right in Fig. 7, and again in Fig. 10, are given details of the supporting standards. The slat guide frame shown in Fig. 7 is shown again in end elevation in Fig. 11. A cross section on line XX, Fig. 7, is represented in Fig. 12. Details of the driving terminal gear to a larger scale are given in plan and elevation by Figs. 14 to 20, Plate LIX, while Figs. 30 and 31, page 664, show views of the approach and discharge sides respectively.

The two rope-driving wheels are fitted with renewable chilled treads, each wheel being cast in one piece with its spur ring which meshes with a corresponding pinion on the main countershaft, C, Fig. 14. To ensure free gear contact, one rope wheel is keyed to the main shaft, whilst the other is loose, but as both wheels are driven they impart the same motion to both the main and auxiliary ropes. The revolutions of the 10 h.p. driving motor are 725 per minute, and the belt and gear drive results in a speed for the conveyor ropes of 150 ft. per minute. At the driving end, while the upper main and auxiliary load-carrying ropes pass on to the terminal wheels in a straight line, the lower auxiliary rope is diverted sideways, for reasons already given, as shown in Fig. 15, as it leaves the driving terminal. The deviation is secured by four horizontal grooved wheels shown in plan and elevation in the illustrations, Figs. 14 and 15, while further details are also shown in Figs. 16 to 19. Fig. 20 illustrates the method of using a double conveyor slat.

The tension terminal is illustrated in Figs. 21 to 29, Plate LIX. The tension gear carriage is mounted on wheels running on a short rail track, clearly shown in Figs. 21, 22 and 28, to provide the range required for the stretch of the rope, &c. The main and auxiliary ropes are kept taut by a suspended weight acting on the tension carriage, as shown in Fig. 28. A separate screw adjustment is provided in connection with the auxiliary rope (Figs. 22 and 23) for the purpose of equalising the tension on the two ropes. There are also at the tension terminal, two horizontal guide sheaves, for diverting the auxiliary rope as it leaves the terminal, in order to permit of the free passage of the slat ends from one side of the rope to the other. In order to reduce the number of guide pulleys in this connection, the terminal sheave for the auxiliary rope is canted as shown in Fig. 25. At the rear end of the tension carriage two sheaves are shown. These are for the purpose of applying the necessary tensional pull, as will be clear from our illustrations.

A set of intermediate supporting idlers is shown in Figs. 32 to 37, annexed, which give end and side elevations, as well as details of the sheaves and bearings. It is obvious that there is no difficulty in obtaining proper support for the upper ropes. The clips which fasten the slats or other conveying devices to the main rope will pass readily over the sheaves. It is otherwise, however, in the case of the main return rope, where the clip nuts are on the under side. Due to this fact, while ordinary sheaves support three of the ropes, as in Fig. 33, the fourth rope is supported from below the slats, the ends of which run over an endless roller chain (shown in Fig. 32) working on a path so shaped that the slat ends enter and pass along the roller chain without disturbance or shock.

At the driving terminal the main and auxiliary rope or ropes pass half-way round their respective wheels, which are naturally on the same shaft, but at the tension terminal the wheel round which the main rope, with its attached carrier bars, passes, need have no relation to the centre of the auxiliary rope sheave or sheaves, which may be to the rear of that of the main rope. Alternatively, the auxiliary tension gear can be arranged at any point between the terminals. In either case the respective lengths of the main and auxiliary ropes are immaterial, as each rope has its own tension gear or means of separate adjustment susceptible of considerable range.

In an alternative method of transferring of the unattached ends of the carrier bars from the one side to the other of the endless rope, the bars with telescopic ends are automatically shortened to clear the rope and then lengthened again on the other side of it. There are also other methods for attaining the same end.

The supporting standards in the installation, which is here illustrated, are spaced about 21 ft. apart, and except at the discharging terminal—which is raised some 15 ft.—they are very low in order that the upper ropes should have a height of barely 2 ft. above the ground level, so that the loads may be conveniently placed on any part of the conveyor. When a conveyor was fully loaded, the rope sagged only 3 in. between the intermediate standards.

The total length of the conveyor we illustrate is 1,800 ft. from centre to centre, the difference in altitude between the loading and unloading points

PORTABLE SCARPHING MACHINE

CONSTRUCTED BY MESSRS. TELFORD, GRIER AND MACKAY, LIMITED, ENGINEERS, GLASGOW.

Fig. 1.

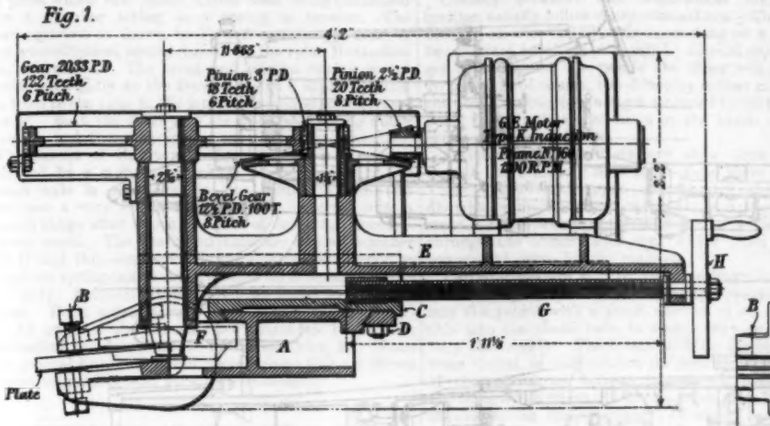


Fig. 2.

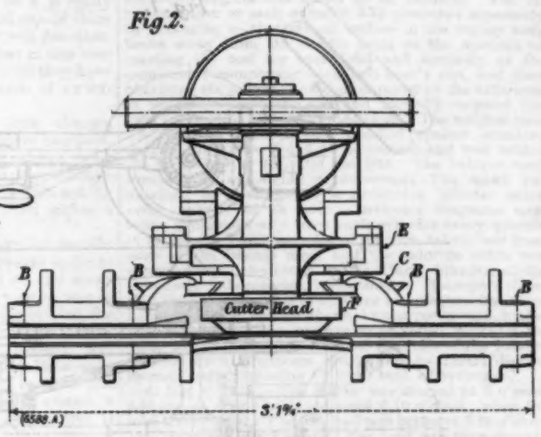
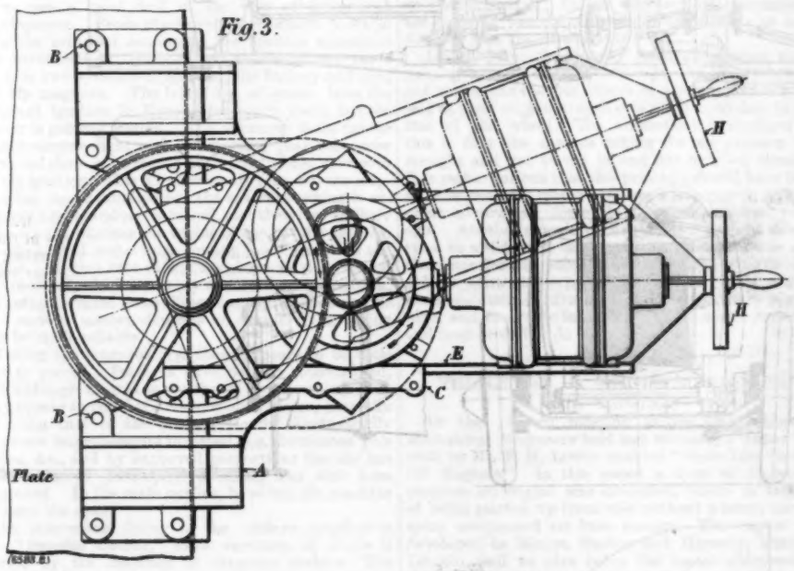


Fig. 3.



PORTABLE SCARPHING MACHINE.

An interesting shipyard tool which is to be seen at the Glasgow Engineering Exhibition on the stand of Messrs. Telford, Grier and Mackay, Limited, of Carrick-street, Glasgow, is illustrated in Figs. 1 to 3 herewith. This is a scarphing machine introduced by the Skinner and Eddy Corporation of Seattle, Washington, U.S.A., of which the British representative is Mr. W. C. Kaelin, of 6, Lloyd's-avenue, E.C. 3. Messrs. Telford, Grier and Mackay build the machine in this country. The tool is a portable self-contained one driven by an electric motor, which is mounted on it, and is capable of cutting a scarph at any angle of any length up to 16 in. and any width up to 8 in. The machine is said to be able to cut a scarph in 10 minutes, or, allowing for moving and setting-up, in an overall time of 20 minutes. These figures, of course, compare very favourably with the time necessary to form a scarph by chipping.

The machine is simple, and free from complicated adjustments or delicate parts likely to give trouble. As will be seen from Figs. 1 to 3, it consists of a frame A with a deep slot at its front side. The plate to be scarphed is held in this slot and clamped by the set screws B. By adjustment between the upper and lower screws the plate may be set at the desired angle. To obtain an angular setting relative to the edge of the plate the whole of the upper part of the machine is made to swivel, the swivelling head C swinging round the vertical cutter spindle and being clamped by the bolt D. The head is shown in a second swivelled position by broken lines in Fig. 3. The slide E, which carries the motor and the whole of the gearing, is carried in vees on the swivelling head and can be fed forward by the hand wheel H and screw G. This gives the cutting feed to the cutter head F which carries the tools. The cutter head is driven from the motor by the gearing, the arrangement of which is clearly shown in Fig. 3. The machine would appear to be very handy and promises to be of great service in shipyards.

is 15 ft., this difference being against load. Ten brake horse-power is required to drive the conveyor under full load. The speed is 150 ft. per minute. The ropes employed are 1¼ in. circumference, 6/7 construction, Lang's Lay, of crucible steel, giving a safety factor of rather over six after taking into account tension and driving pull.

The circumstances which led to the conception of this conveyor are rather interesting, as the invention owes its existence to the requirements of the War Office. It is known that the empty munition and shell boxes were principally collected from the Front at a dump at Zeneghen, on a canal a few miles from Calais. These boxes arrived in railway trucks, and an army of Chinamen assembled there nailed on the lids ready for despatch to this country. These boxes, sufficiently well repaired and packed for the journey, were handled at the rate of 3,000 per hour, equivalent to a conveyor capacity of 75 tons per hour. The cases varied considerably in size, the average being 2 cub. ft. The work of packing, &c., occupied a strip of ground about one-third of a mile in length along a railway siding. A mechanical handling device was, therefore, thought to be necessary by the military authorities, so that boxes could be loaded at any point along its length, every case, as soon as it was ready, being placed on the conveyor and subsequently delivered over the end of the discharging terminal. The officer in charge of this work, realising that the distance was too great for one of the standard types of continuous conveyors, applied to Messrs. Ropeways, Limited, for a slow-running ropeway, presumably with a great number of specially-designed carriers. While such a solution might have met the case, it was realised by Mr. J. Pearce Roe, the managing director of that firm, that this was not the best form to adopt, and the type of conveyor described was devised and submitted. The proposal was approved by the military authorities, and the plant was built. Before despatching the installation to France, however, a length of 150 yards was erected in this country and subjected to a variety of tests. These proved highly satisfactory when tried with cases identical to those handled at the Zeneghen Dump and with individual loads far in excess of those for which it was designed, such as hay-bales, heavy bags of rivets, and the like.

The novel features in this system permit wire ropes to be advantageously used for conveyors instead of the usual chains. There has also been a great need for a design of conveyor which would eliminate the continuous girder-work associated with the endless chain or band conveyors. Wire ropes, on account of their lightness, flexibility and strength permit relatively larger clear spans to be worked, by allowing the ropes to sag slightly. Needless to say, the application of wire ropes tends to lessen first cost and upkeep, and what is more important, this construction is applicable to relatively long-distance transport, whilst permitting the use of slats, carrier or trunnion bars, troughs, buckets or the like, for supporting or containing the material to be conveyed. Figs. 4 to 6, on page 665, actually show, for instance, the slat and endless trough type of conveyor.

The licensees for Great Britain for the Roe cable conveyor are Messrs. Ropeways, Limited, of Eldon-street House, Eldon-street London, E.

NICKEL-CHROME STEELS FOR THE HAIR-SPRINGS OF WATCHES.—The compensation of the dilatation of the balance wheel by the aid of hair springs of nickel-steel, which has been in use for about twenty-five years, is not complete. When the thermal coefficient of the elasticity of nickel steel is plotted as the ordinate against the nickel percentage as abscissa, a curve is obtained which crosses the zero line at about 29 per cent. Ni and rises steeply to a maximum at 36 per cent., to fall off rapidly again and to cross the zero line once more at 45 per cent. At both these points the rate of change of the coefficient is very rapid, so that a slight mistake in the composition of the steel leads to serious defects in the compensation. In his researches on the anomalies of nickel steel, C. E. Guillaume, of the Bureau des Poids et Mesures, found (*Comptes Rendus* 171, pages 83 to 87) that the addition to the nickel steel of a third metal made the thermoelastic curve nearly level. Experimenting in conjunction with the Aciéries d'Imphy, the Société des Fabriques de Spiraux Réunies and the watchmaker Paul Ditisheim, he obtained the best results with a steel containing 36 per cent. of nickel and 12 per cent of chromium; the latter metal could be replaced by its equivalent of manganese, tungsten or carbon. The important advantage gained is that hair springs of this alloy can be combined in the best watches and even in chronometers with the balance wheels of ordinary watches, the balance wheel having only to compensate for dilatation, but not for variation in the elasticity,

THE LEYLAND EIGHT-CYLINDER MOTOR CAR.

CONSTRUCTED BY MESSRS. LEYLAND MOTORS, LIMITED, ENGINEERS, LEYLAND.

Fig. 1.

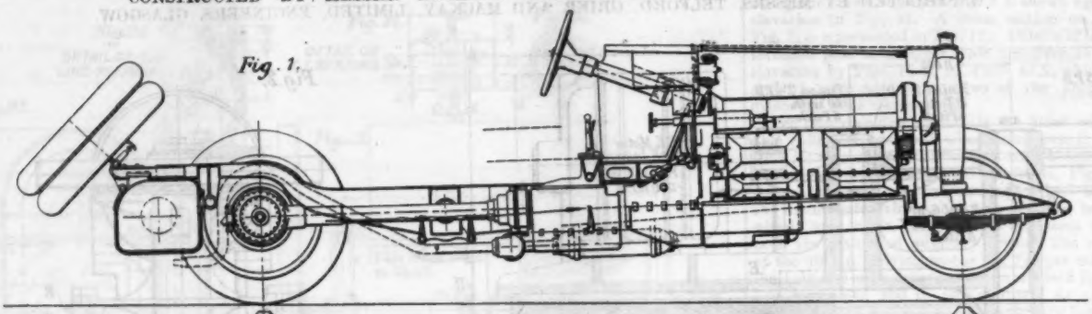
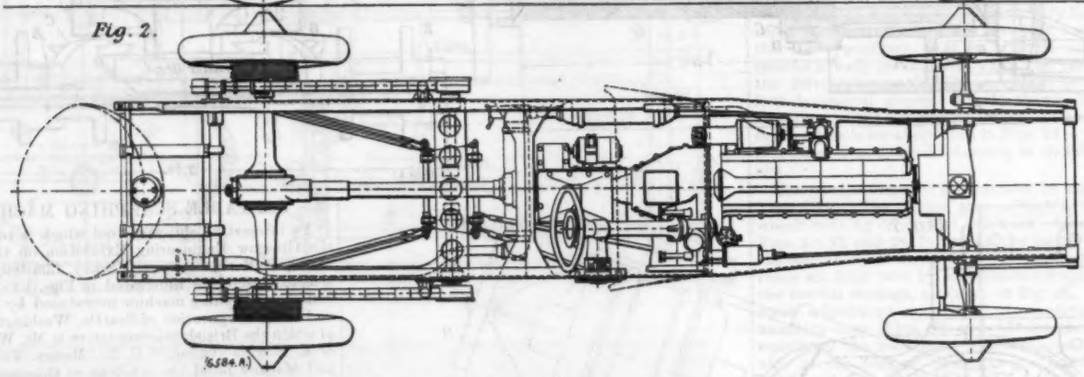


Fig. 2.



PERHAPS the most interesting car in the recent Motor show was that exhibited by Messrs. Leyland Motors, Limited, Leyland, Lancashire. This firm has been well known for its commercial vehicles for many years and therefore their new pleasure car is of great interest, especially as it contains many unconventional features. We give drawings of this car in Figs. 1 to 6, on this page. Of these Figs. 1 and 2 show elevation and plan of the chassis, and Fig. 3 an end view of the same. Fig. 4 shows a detail of the steering pillar, &c.

The engine is eight-cylinder vertical with the cylinders, which are 3½ in. diam. by 5½ in. stroke, in line, the four middle cranks being arranged as in the ordinary four-cylinder engine, while Nos. 1, 2, 7 and 8 are at right angles to them, 1 and 8 being together and 2 to 7 being together, but opposite to 1 and 8. This gives practically perfect balancing, with of course extremely even turning moment. The cylinders are all cast *en bloc* in one piece with the top half of the crank case, and are of cast iron. Detachable heads are used, the valves being in the heads inclined at 45 deg., the inlets on one side and exhausts on the other. All are driven by a single overhead camshaft placed above the centre line of the cylinders. Rocking levers are employed to work the valves and a single leaf spring is used for each pair of inlet and exhaust valves. The valves are extremely light following aero practice.

In place of the camshaft being driven by a vertical shaft as usual, there is at the after end of the crank case a short shaft driven at half engine speed by helical spur gear. This has on it three eccentrics, and these are connected to three eccentrics on the camshaft by connecting rods. The inlet and exhaust manifolds are all cast in the cylinder block and the exhaust is brought through between the cylinders to the inlet side and jackets the inlet from the carburettor. Five bearings are provided for the crank shaft. The pistons are of aluminium of the slipper pattern with the head only connected with the rest of the piston near the centre so that the expansion of the head has little effect on the clearance of the slippers. The piston rings are aluminium.

Lubrication is forced to all parts of the engine including the gudgeon pins and camshaft. The oil tank is, however, not below the crank case as usual, but alongside it. The oil flows from the crank case into the flywheel housing and is thrown from there into the tank by centrifugal force from the flywheel. A single plate clutch transmits power to a four-speed gear box. This is carried in a peculiar manner. The front end has a spigot fitting into an extension piece bolted to the crank case, a leather ring being interposed between the two. The after end is carried on a cross-piece of the frame through steel and leather discs. It is claimed that this reduces noise as the frame cannot act as a sounding board for the gears and also that the gear box is isolated from the distortion of the frame. Electric light and self-starter are provided and ignition is by coil and distributor.

Fig. 3.

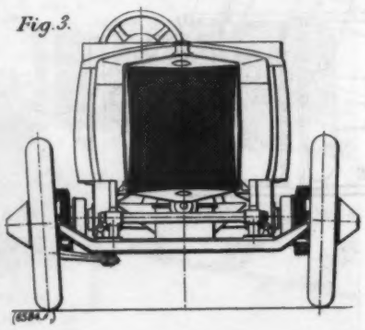


Fig. 4.

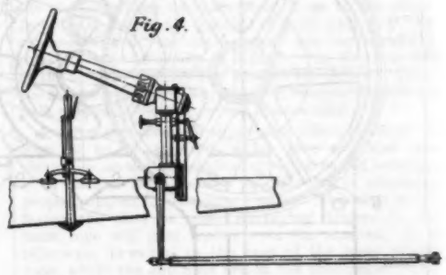


Fig. 5.

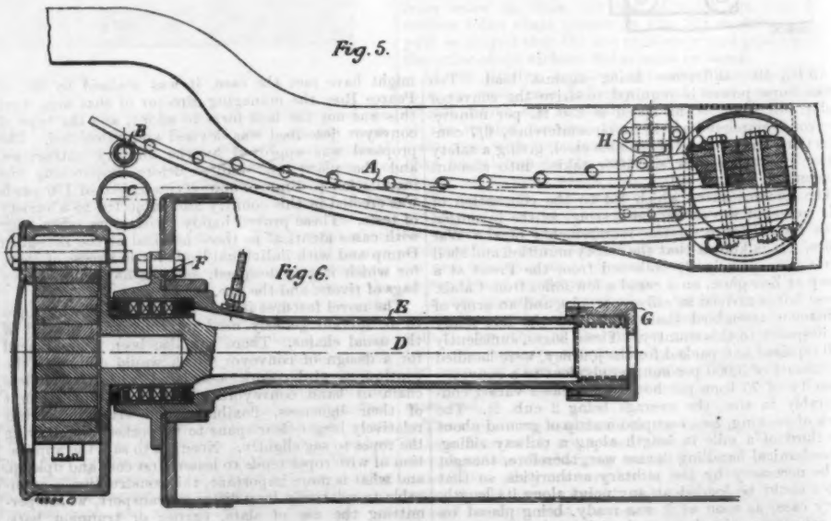


Fig. 6.

The final drive on the back axle is by bevel, but in place of the usual arrangement the differential gear is on the longitudinal shaft and there is a crown wheel on each axle shaft. The back wheels are splayed out at the top. The foot brake is a vacuum brake, working with

the vacuum from the inlet pipe and so arranged that the brake pressure is graduated according to the movement of the clutch pedal.

The back springs are quarter-elliptical, but the front of the spring is not fixed to the frame, but to a pivot which can rotate under load being controlled by a member acting as a spring in tension. The arrangement is shown in Figs. 5 and 6, opposite. A quarter-elliptical spring A rests on the roller B attached to the axle C. The front end of this spring is not attached rigidly to the frame, but to a shaft D which is fixed to the tube E, the latter being fixed to the frame at F. Both the shaft and the tube can spring under torsion and therefore give a very sensitive springing. The extent of this torsional movement is, however, limited by a stop—after which the movement of the back axle is controlled by the spring A. In this manner a very sensitive motion can be given over a small range after which the rate of deflection becomes more usual. The shaft and tube are locked together at G and this connection is capable of adjustment so that the spring can be set as desired for different weights of body. Semi-elliptical springs are fitted to the front axle. Both axles have anti-rolling devices.

All parts of the chassis have automatic lubrication including such parts as the spring shackles, &c. Both in general lines and detail arrangement this car shows great originality and very careful design.

ACCESSORIES AT THE MOTOR SHOW.

IN the matter of accessories at the recent Motor Show there was not very much of real novelty, though there was a good deal in the way of interesting development. From the purely mechanical point of view the principal accessories are ignition apparatus and carburettors. With regard to the former there are now two systems of ignition, the battery and coil, and the magneto. The latter has, of course, been the standard ignition in Europe for many years, but the former is gaining ground. The argument in its favour is that electric light and self-starting gear being now universal there is no reason for an additional generator for the ignition. This is undoubtedly true, but the magneto has the advantage that the external wiring is extremely simple and easily traced, and therefore unlikely to go wrong, whereas the wiring of the battery ignition is complicated and a wire coming loose may stop the engine. In this case difficult wiring has to be traced and rectified, which is no easy matter should it be dark, as it often is when these things happen. Whether this is a serious matter depends on how far the wiring can be made reliable.

Taking the magneto first there appears to be little new to record. Patterns have become standardised, and although magnetos are shown by numerous firms they appear to be all of a conventional design, generally following that of the pre-war Bosch. Undoubtedly there are improvements in detail, *e.g.*, laminated pole pieces, &c., and by improved proportions the size has been reduced. Low-speed sparking has also been improved. In the main outline, however, the machine remains the same.

An interesting fitting to the modern magneto is the "impulse starter," some variation of which is shown by the majority of magneto makers. The principle of the impulse starter is by no means new, as a device of this kind was shown at Olympia several years before the war and described in these pages. It then attracted little attention, however, but was reintroduced from America during the war, and may now come into general use. The impulse starter is a mechanical device for overcoming a defect of a magneto, namely, that it will not spark below a certain speed. The impulse starter consists usually of a circular box mounted loose on the armature spindle and having inside a coil spring. Normally the spring is under considerable tension and holds the box against a stop in the spindle. When the engine is running at speed the whole revolves together. When used for starting purposes, however, the armature spindle is caught by a pawl about 30 deg. from the top centre of the engine and held there. As the engine rotates the box is also rotated and the spring compressed. When the piston gets just over the top centre the armature shaft is released and rotates rapidly under the tension of the spring till it comes again against the stop. The rotation is very fast and the spark therefore as large as if the engine were running full speed. Two effects are secured by this device. In the first place, a full spark is secured however slow the engine is turning; in the second an automatic retardation, and therefore no possibility of backfire. There can be little doubt as to the advantage of such a device. However well an engine may start when things are all right there are times when it is sulky and, whether electric or hand starting is being used, a perfect spark at low speeds is an advantage. Many variations of detail design are shown, but there are only two which involve difference in principle. In some of the machines the impulse starter cuts in below some specified speed automatically and cuts out above that. In others the device has to be put into action each time, but cuts out when the engine reaches a certain speed. Probably in practice there is little to choose between them.

Contact breakers and distributors for battery ignition usually follow conventional lines. The contact breaker on the Caddillac is interesting as it is really two contact breakers in parallel. Should one of them get dirt between the points the other will function. In practice, of course, the difficulty is that in this case the defective one does not get attended to till they have both failed unless the car is in the hands of an exceptionally careful man.

Generators and self-starters show little change, though the tendency is to make them more compact. There are several types of generator shown with distributor incorporated, making a compact arrangement. There are also generators with the shaft coming through the commutator end, which often makes a convenient drive for the magneto.

Carburettors are still of great variety, but usually follow old principles. The tendency appears to be to mix the petrol with a small amount of air and spray this into the choke tube in such a way as to mix it very thoroughly. There can be little doubt that the main defect of carburation at present is the failure of the petrol to become completely gasified, and anything which mixes the air and petrol more intimately should be an improvement. Vacuum feed for the petrol has become very general. In this system a small tank is placed in the bonnet, and petrol is sucked up into it from the main tank by the vacuum on the inlet pipe. In one carburettor arrangements are made to use the vacuum of the suction to suck directly into the carburettor.

Among tyres the "cord" principle appears to be gaining ground a good deal. In this the fabric is not woven canvas but layers of straight threads are laid at right angles to each other and at 45 deg. to the line of the wheel. The theoretical advantages of this is that the threads taking the air pressure are straight and not woven in and out of other threads. It is rather curious that this principle should have been so little used for motor tyres as it was proved to have great advantages for cycle tyres twenty-five years ago. Another new departure is the "straight-sided" tyre, in which each bead has an inextensible wire and the rim is flat with straight sides, one side being detachable to allow the cover to be changed. This pattern has some distinct advantages over the ordinary beaded edge, and has come into considerable use in America, and may probably do so here.

TRIALS OF A HIGH-COMPRESSION OIL ENGINE.

AT the Lincoln meeting of the Institution of Mechanical Engineers held last summer, a paper was read by Mr. F. H. Livens entitled "Some Lincolnshire Oil Engines." In this paper a type of high-compression oil engine was described, which is capable of being started up from cold without a lamp, merely using compressed air from storage. This engine was developed by Messrs. Ruston and Hornsby, Limited, Lincoln, and we give below the report addressed to this firm of trials carried out at their request on such a machine, by Captain H. Riall Sankey, C.B., R.E. (retired). We have abridged paragraph 6 of this report, having omitted certain references to diagrams not reproduced. We may mention that this design of engine was fully illustrated and described in our issue of July 2, page 8 *et seq.*

Captain H. RIALL SANKEY, C.B., R.E. (ret.), M.Inst.C.E.,
Marconi House, Strand, London, W.C. 2.

Dated August 23, 1920.

DEAR SIRS,—In accordance with the request expressed in your letter dated June 18, 1920, I conducted a trial of one of your high-compression engines (cold starting engine) on July 15.

1. *Object of Test.*—The object of the test was to ascertain the oil consumption per brake horse-power at various loads.

2. *Type of Engine.*—The engine tested was of the horizontal type, having two side-by-side cylinders, firing alternatively, and cranks at 0 deg. The flywheel was on one side of the engine and the load was applied by a Heenan and Froude brake bolted to the flywheel boss. The particulars of the engine are: Cylinder diameter, 18½ in.; stroke, 30 in.; revolutions per minute, 175; rated brake horse-power, 260. This type of engine works on a four-stroke cycle. During the out-stroke, following the exhaust of the products of combustion, pure air is drawn in and then compressed to about 450 lb. per square inch during the following in-stroke. The compression temperature is amply sufficient to ignite the oil, which is forced into the cylinder at about the turn of the stroke by an oil pump, giving an adequate pressure to atomise the oil. Owing to the high compression temperature, preheating of a hot bulb is unnecessary and the engine can therefore start from cold. The combustion is therefore partly at constant volume and partly at constant pressure, which is thermodynamically somewhat more efficient than combustion at constant pressure.

3. *Method of Testing and Apparatus Used.*—The method of testing was that in current use at your works, and all measurements were taken by your staff under my supervision. As already stated, the load was applied by means of a Heenan and Froude hydraulic brake. The weights used with this brake were compared with standard weights and found to be accurate. The oil consumption of each cylinder was measured separately by arranging so that the oil surface in the supply tank broke away from the needle point at the moment of starting the test for each load and similarly at the moment of completing each half-hour's run, and then obtaining the weight of oil thus required by the difference in weight between the full and partially emptied can used for pouring the oil into the tank. The weights used for weighing the oil were checked against standard weights, and were found to be correct and well within the limits of the errors of the test. The balance used turned with one-eighth of an ounce. The speed was obtained by readings of a revolution counter taken every quarter of an hour. Indicator diagrams were taken simultaneously from each cylinder every quarter of an hour. Three samples of oil were taken, one from each of the barrels used, and the calorific value was subsequently determined by Mr. Harry Stanger, of the Broadway Laboratories, Westminster. His report shows that the calorific value of all three samples was the same, namely, 19,260 British thermal units per pound, higher calorific value. The lower calorific value, which is the value to take in accordance with the rules of the Institution of Civil Engineers, works out to 18,051 British thermal units, assuming 13·9 per cent. of hydrogen.

4. *Log of Tests.*—The engine was started at 8 o'clock and ran at about half load until 9.10 o'clock, when full load was applied. The full-load test began at 9.20 o'clock and continued for 3 hours. The load was then quickly lessened to three-quarter load, which was maintained for 1 hour. After this the load was reduced in succession to one-half load and one-quarter load each for 1 hour, after which the engine was run with no load for a quarter of an hour; then an overload approximately of 10 per cent. was applied for half an hour. Lastly, the quarter load test was repeated for an hour, and the trial ended at 6 p.m.

5. *Results of Test.*—The test figures are given in the table herewith.

Consumption per B.H.P. Hour at Various Loads.

Lower calorific value of oil—18050 B.Th.U. per lb.

Proportion of Full Load.	Average Revolutions per Minute.	Average B.H.P.	Oil Consumption. Pounds of Oil per B.H.P. Hour.
Overload	174·1	261·1	0·403
Full load	175·57	235·9	0·401
Three-quarter load ..	177·15	178·2	0·401
Half load	179·33	119·9	0·405
Quarter load ..	181.1	60·4	0·508

6. *Conclusions from Test Figures.*—The total average oil consumed per hour plotted on a brake horse-power base gives a fair line, which in the central portion is almost quite straight, following the Willans law. Both at the full load end and at the no load end the line curves slightly upwards. The final result thus obtained is more reliable than by plotting the oil consumption per brake horse-power hour. The minimum consumption obtained by calculation from this line is about 236 brake horse-power, and is 0·401 lb. per brake horse-power hour. The economy of the engine expressed in British thermal units per brake horse-power per minute gives the low figure of 120·7, and the highest figure for thermal efficiency reckoned on the brake horse-power was 35·1 per cent. It was considered unnecessary to obtain the indicated horse-power from the indicator diagrams. The table gives the oil consumption per brake horse-power hour at various loads taken from the "faired" line.

7. *Governing.*—The action of the governor was observed during the trials, especially when changing load. The variation of speed was very small and even with rapid changes of load. The speed at various loads is shown in column 2 of the table; there was no hunting.

8. *Behaviour of Engine.*—Throughout the trial the engine ran remarkably well and so uniformly that it was impossible to tell by sound what load was on the engine, and when such load was changed.

Yours faithfully,
H. RIALL SANKEY.

PERSONAL.—The Right Hon. Lord Sydenham of Combe has been elected to the office of President of the British Empire Producers' Organisation.—We are informed that on and after to-day, November 19, the address of the Association of British Motor Manufacturers, Limited, will be 40 and 41, Conduit-street, London, W. 1. Telephone No.: Mayfair 6524.

THE CARNEGIE STEEL COMPANY.—The Carnegie Steel Company, says *The Iron Trade Review*, Cleveland, Ohio, has purchased several hundred acres of land adjacent to and including the Cascade Ball Park, New Castle, Pa. Reports are current that the company will build enough by-product coke ovens on this tract to supply its four blast furnaces in that city. It is also rumoured that an open-hearth plant may be erected on its present steel-mill property. Several million dollars have already been appropriated, although it is not known definitely when the contemplated building programme will be commenced.

25-KW. EMERGENCY SHIP'S LIGHTING SET.

CONSTRUCTED BY MESSRS. JOHN I. THORNYCROFT AND CO., LIMITED, ENGINEERS, BASINGSTOKE.

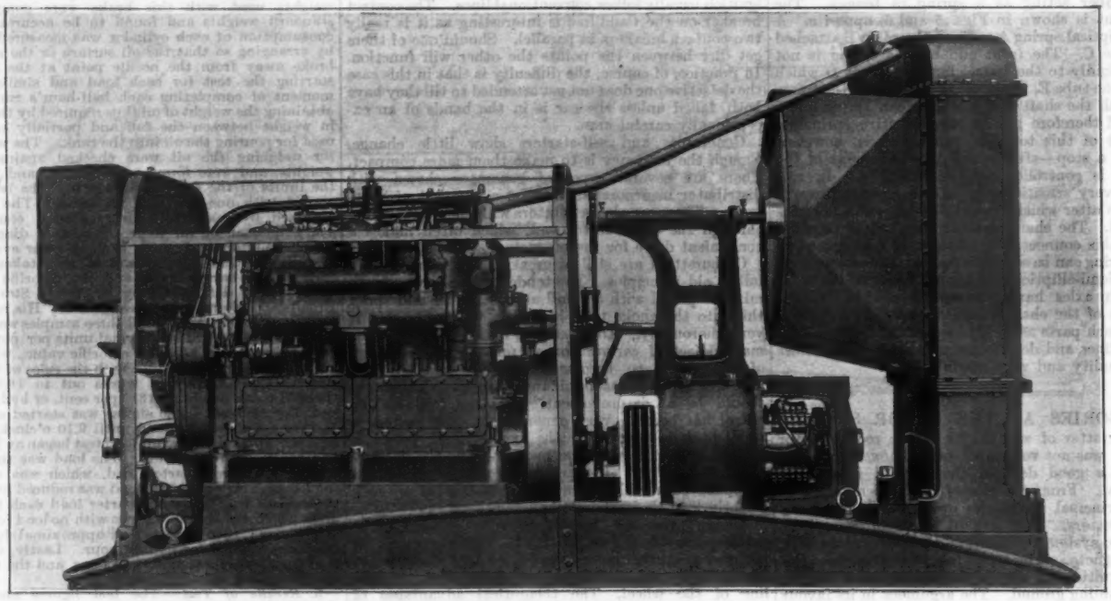


FIG. 1. GENERAL VIEW OF PLANT.

AN interesting installation at the Glasgow Engineering Exhibition, which we deal with more fully on page 678 of this issue, is an emergency ship-lighting set shown on the stand of Messrs. John I. Thornycroft & Co., Limited, whose London office is at 10, Grosvenor Place, S.W. 1. The complete set, which is illustrated by the half-tone engraving, Fig. 1, on this page, comprises a paraffin engine, directly-coupled to an electric generator and mounted on a cast-iron bedplate, together with the fan and radiator and fuel tank. It is built to Board of Trade requirements and fulfills the conditions laid down by the International Convention for the Safety of Life at Sea. The engine is one of the firm's C. 4 type stationary motors, developing 50 b.h.p. on paraffin and 60 h.p. on petrol, and running at about 750 r.p.m. The normal output of the set is 25 kw., but it is capable of a maximum output of 30 kw. The general arrangement will be clear from our illustration, Fig. 1, while the design and construction of the engine can be followed from the sectional drawings reproduced in Figs. 2, 3 and 4 on the opposite page.

The engine is of the four-cylinder type, having cylinders 6 in. in diameter, with a piston stroke of 8 ins. Sections through the cylinders are given in Figs. 2 and 4, the former also showing one of the pistons in section. The latter are of pressed steel, with four gas rings, and the gudgeon pin, which is hardened and ground, is secured as shown in Fig. 4. The connecting rods are of mild steel fitted with bushes lined with white metal in the big ends. The crank shaft, which is also of mild steel, is carried in three main bearings lined with white metal, oil to the bearings being supplied by a pump of the gear-wheel type shown in Fig. 4. A rotary pump is also fitted for water circulation. The cam shaft, shown in the same illustration, is of mild steel ground on the bearings, and the cams are case-hardened and ground; half compression gear is fitted for ease in starting. The arrangement of the valves, which are of nickel steel, is shown in Figs. 2 and 4. The exhaust valve, shown in the latter figure, is operated directly by a tappet, while the inlet valves, are operated by push rods and rockers as shown in Fig. 2.

A section of the vaporiser, which is heated by the exhaust, is given in Fig. 3. The fuel normally employed is kerosene, or paraffin lamp oil, although petrol or benzine can be used with this vaporiser if desired. When starting up, the engine is usually run for about 10 minutes on petrol to heat up the vaporiser, but, if petrol is not available, the vaporiser is heated by a blow lamp for about the same period before attempting to start the engine. Ignition is by means of a high-tension magneto with adjustable timing, and a governor of the centrifugal type is also fitted; the speed variation, it is stated, does not exceed 5 per cent. up to 75 per cent. of full load. At full load the consumption of paraffin oil is given as 0·85 lb. per brake horse-power hour, and the corresponding figure for petrol as 0·75 lb. It may perhaps be noticed that the arrangement of the starting handle in Fig. 2 differs somewhat from that in Fig. 1. In the latter, the handle is placed directly on to the crankshaft, while in the former it is connected through a roller chain, this being the arrangement adopted when the engine is used for marine propulsion; in other respects there is little difference between the engines used for marine and stationary work.

Messrs. Thornycroft also show a 15 h.p. paraffin engine direct-coupled to a Gwynne centrifugal pump, and capable of delivering 340 gallons per minute against a head of 70 ft. On account of its portability and compactness, the set is particularly suitable for country-house, farm and plantation work, as well as for fire prevention and many other purposes.

THE ELAN AQUEDUCT, BIRMINGHAM CORPORATION WATER WORKS.

*Cross Connections on the Elan Aqueduct of the Birmingham Corporation Waterworks.**

By FREDERIC WILLIAM MACAULAY, M.Inst.C.E.

THE paper recites the events which led up to the adoption, on the three longest syphons on the aqueduct, of cross-connections between the two, approximately, 42 in. diameter mains of which they consist. Primarily these were considered as a means of accelerating the process of recharging the unbroken portion of a main after the failure of a pipe upon it. It was further anticipated that, with one whole main cross-connected to portions of the other, more water would be passed for supply than could be passed through one main only worked independently. Fuller consideration led to this becoming the paramount aspect of the scheme.

It was intended originally to cross-connect at points on the mains at which 6-in. diameter air-valve branches—very suitable in some respects for the purpose—existed. But the consideration of augmented discharge by means of the cross-connections led to these latter being fixed actually at points where 18 in. diameter branches existed, opposite each other on the two mains. The present position of the cross-connections is, however, regarded as temporary only, pending the future adoption of a complete scheme.

Those already installed are described and illustrated. Thirty-one have been installed, 11 on the Downton siphon (9¼ miles long), 5 on the Team siphon (4½ miles), and 15 on the Severn siphon (17½ miles).

Tests were made, as opportunity occurred, from which a curve was plotted, for each siphon, of discharge with varying lengths of single and double main cross-connected. The horizontal ordinate of the curve is the total length of effective single main—in however many separate sections it may chance to be—the vertical ordinate the quantity discharged for that length of single main with the remainder of the siphon of double main. The curves are illustrated.

The hydraulic problem involved is described and illustrated, showing that by means of the flatter hydraulic gradient—than that of a single main—obtained on the length of double main, with the consequent steepening of that on the length of effective single main, there results a greater flow than could be obtained through a single main only throughout the siphon. Details of one such test are given in illustration.

The benefits obtained by means of the cross-connections already installed are set out. These may be summed up as the ability to maintain a flow but little less than that of two complete mains during the execution of main cleaning or repairs of any description upon one of them.

The adaptability of the cross-connection system to the augmentation of siphon capacity is next dealt with. The scheme adopted for this purpose on the Elan aqueduct is described shortly. It consists of laying alongside and cross-connecting to the two existing mains, forming the three siphons previously named, such lengths of 60-in. diameter main as may be requisite to meet the increased and increasing demand for water in Birmingham.

A disadvantage in connection with the system is mentioned as lying in the liability, in the event of failure of one main, of the automatic valves on all the mains being brought into action, thus cutting off the whole flow temporarily. On the Elan aqueduct no means to counteract this are at present contemplated; it is considered that, compared with the advantages gained, this drawback is not serious enough to justify the cost of means for counteracting it.

The advantages anticipated from this scheme are: Great reduction of initial capital expenditure. Capital expenditure can be made approximately to keep pace with the increase of aqueduct capacity achieved. Increase of aqueduct capacity can be accelerated, retarded, or even suspended *pari passu* with the demand for water. The full benefit of each increment of capital expenditure will be realised practically immediately, inasmuch as each unit of new main—that is from cross-over to cross-over—can be taken into use, with a consequent increase of aqueduct capacity, as soon as it is finished. Lastly, the duplication of certain classes of special work, of a difficult or expensive nature, may possibly be avoided. An appendix gives the method of calculation for applying the principle to any existing or proposed aqueducts.

* Abstract of a paper read before the Institution of Civil Engineers, on Tuesday, November 16, 1920.

BRITISH INDUSTRIES FAIR, BIRMINGHAM.—Preparations for this fair, which is to be held in the permanent buildings of the Castle Bromwich Aerodrome from February 21 to March 4, 1921, are now well under way, and there is every prospect of the undertaking being a successful one. As far as Birmingham is concerned the floor space is practically all let; a little space, however, remains available, which the promoters wish to settle at the earliest possible moment. Application for such space should be made to the General Manager, 95, New-street, Birmingham.

25-KW. EMERGENCY SHIP'S LIGHTING SET.

CONSTRUCTED BY MESSRS. JOHN I. THORNYCROFT AND CO., LIMITED, ENGINEERS, BASINGSTOKE.

(*For Description, see opposite Page.*)

Fig. 2.

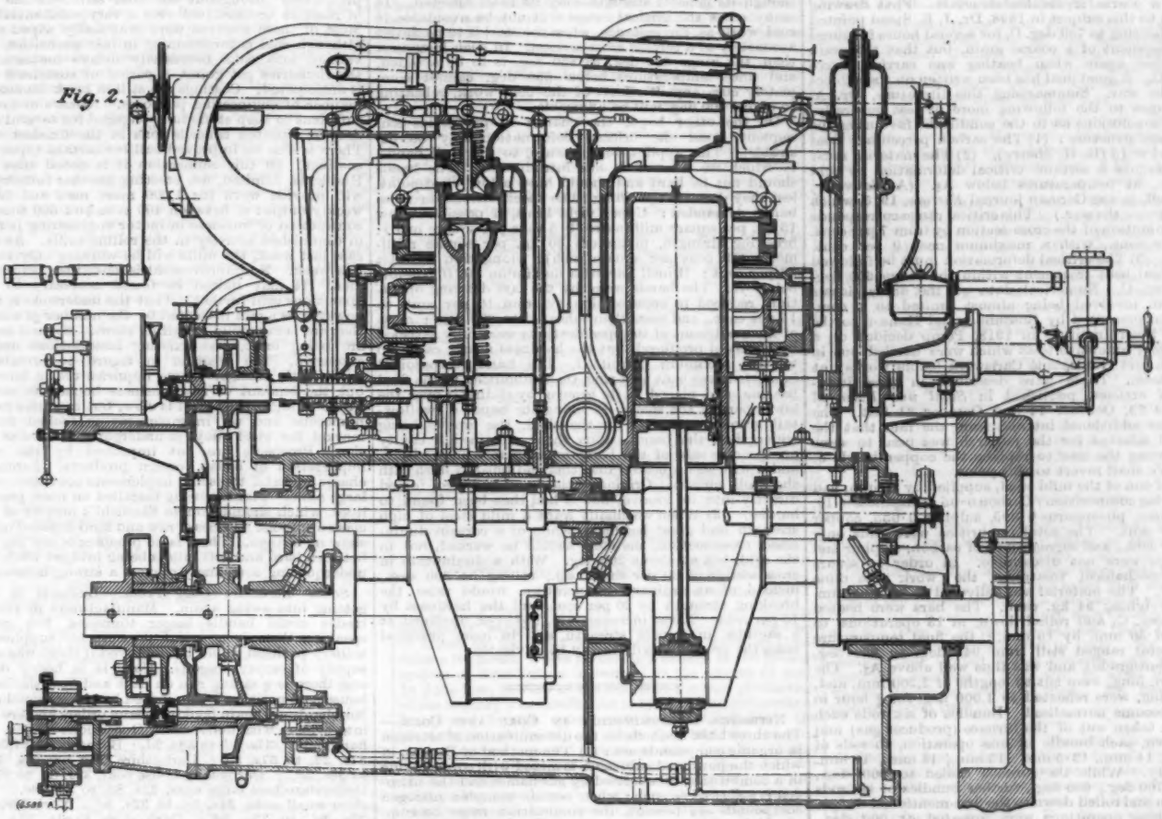


Fig. 3.

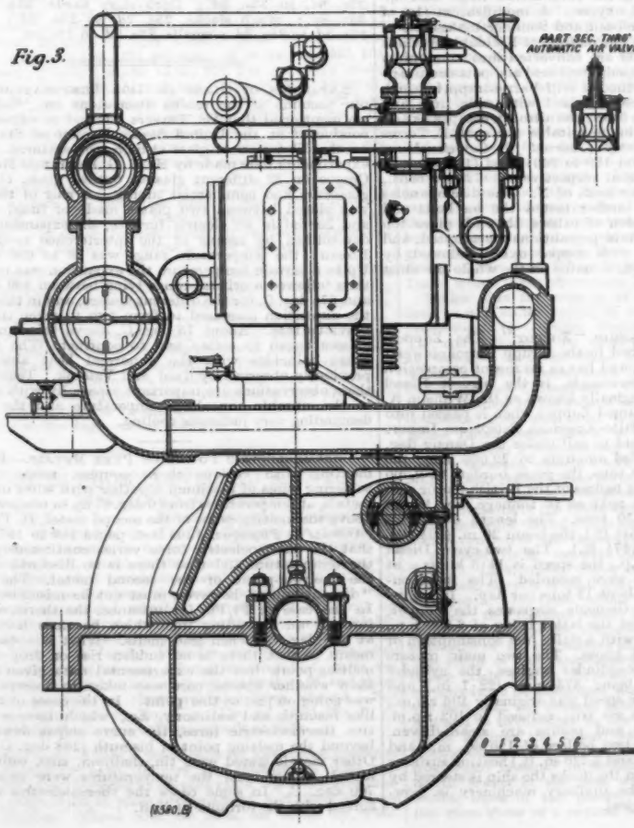
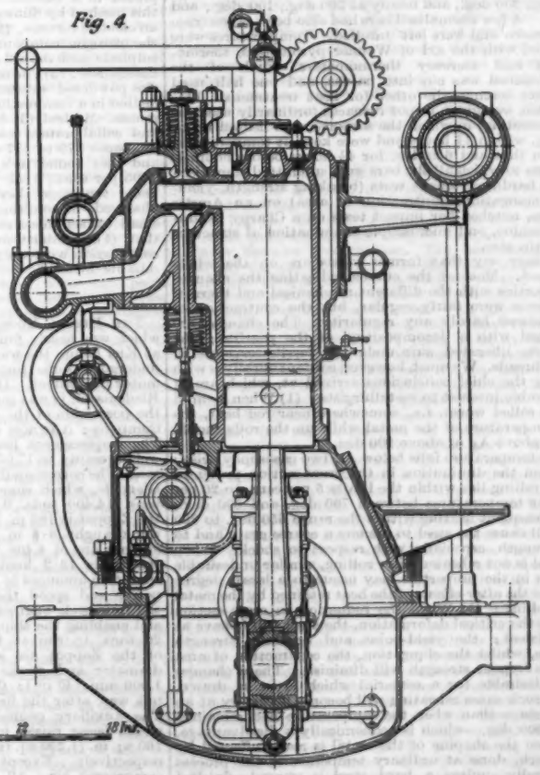


Fig. 4.



CRITICAL HEAT TREATMENT OF COLD-WORKED MILD STEEL.

In recent years complaints have arisen that mild steel, which had undergone mechanical treatment by rolling, drawing, hammering, punching, &c., followed by re-heating, lost its strength apparently owing to the development of a coarse crystalline structure. First drawing attention to this subject in 1898, Dr. J. E. Stead pointed out that heating to 700 deg. C. for several hours favoured the development of a coarse grain, but that the grain became fine again when heating was carried above 900 deg. C. A good deal has been written on the subject during the war. Summarising this literature, Dr. A. Pomp comes to the following more or less generally-accepted conclusions as to the conditions favouring the coarse-grain structure: (1) The carbon percentage does not exceed 0·18 (R. H. Sherry). (2) The material must have undergone a certain critical deformation by cold work, *i.e.*, at temperatures below A_3. (A. Sauveur; C. Chappell, in the German journal *Ferrum*, 1915, which did not survive the war.) This critical range corresponds with a diminution of the cross-section by from 7 per cent. to 30 per cent., with a maximum near 9 per cent. (Sherry). (3) The critical deformation must be followed by a critical heat treatment within the range 650 deg. to 850 deg. C. Numerical data on the actual losses of strength involved being almost limited to a communication presented by Rosenhain and Hanson to the Iron and Steel Institute in 1918, Pomp decided on a series of very extensive tests which were carried out in the Felten and Guilleaume Carlswerk (cable works), at Cöln-Mülheim. These were described in three fully-illustrated articles, published in *Stahl und Eisen* of September 23, October 14 and October 21 last. The paper gains additional interest from the fact that the mild steel selected for the research was used to some extent during the war to replace the copper bands of shells. We shall revert to this point.

The half-ton of the mild steel, supplied by Krupp, had the following composition: Carbon 0·05, manganese 0·10, silicon traces, phosphorus 0·005, sulphur 0·035, copper 0·024 per cent. The total impurities were thus only 0·214 per cent., and segregations of carbon, sulphur and phosphorus were not discernible. In order to secure uniform mechanical treatment the work was done by rolling. The material was delivered in bars 63 mm. square, weighing 54 kg. each. The bars were heated to 1,125 deg. C. and rolled down, in 13 operations, to sections of 30 mm. by 15 mm.; the final temperature of the metal ranged still from 945 deg. to 920 deg. (always Centigrade), and was thus well above A_3. The bars, 14 m. long, were cut to lengths of 2,200 mm. and, after cooling, were reheated to 1,000 deg. for ½ hour in order to become normalised. Bundles of six rods each were then taken out of the furnace (producer gas) and rolled down, each bundle in one operation, to rods of 14·5 mm., 14 mm., 13·5 mm., 13 mm., 12 mm., 10 mm. respectively. While the furnace cooled to 900 deg., 800 deg., 700 deg., 600 deg., further bundles of six rods were taken and rolled down to the first-mentioned dimensions. These operations were repeated at 500 deg., 400 deg., 300 deg., and finally at 200 deg., 100 deg., and 10 deg. A few normalised bars had also been taken from the furnace and were left unrolled. Temperatures were measured with the aid of Wanner pyrometers, thermo-couples and mercury thermometers. Each of the rods obtained was cut into halves, and one half used for direct testing, the other for heat treatment. This treatment was given in pot furnaces (ordinarily used for wire annealing) in which the samples were heated up to 850 deg. within 1½ hours and were kept at temperatures between that and 650 deg. for 4½ hours before cooling. The tests to which all the bars were submitted comprised Brinell hardness, tensile tests (breaking strength, yield-point, elongation, contraction of area) on an Amsler machine, notched-bar impact tests on a Charpy pendulum machine, and microscopic examination of structure and grain size.

We may say that former views are on the whole confirmed. Most of the curves indicating the changes in properties with the different mechanical and thermal treatments were fairly regular, but the contraction of area showed hardly any regularity. The changes are connected with a decomposition of the pearlite; the cementite liberated surrounds the ferrite crystals in beady threads. We must, however, content ourselves with noticing the chief conclusions arrived at, which are of considerable interest to metallurgists: (1) When a mild steel is rolled warm, *i.e.*, somewhere near red heat, the final temperature of the metal while on the rolls should remain above A_3, or above 900 deg.

If the temperature falls below A_3, two cases may arise: (*a*) When the diminution in the cross-section produced by the rolling lies within the limits 5 per cent. to 20 per cent., at temperatures between 700 deg. and 800 deg., any subsequent heating within the range 650 deg. to 850 deg. will cause the steel to assume a coarse grain and to lose strength, especially with respect to shock. When the steel is not reheated after rolling, similar undesirable changes in the properties may occur to a lesser degree owing to the after-effects of the heat retained by the metal after rolling; (*b*) When the reduction in cross-section exceeds the critical deformation, the steel will behave as if hardened; the yield-point and breaking strength will rise, whilst the elongation, the contraction of area and the impact strength will diminish. These changes are undesirable for a material which is to be drawn, and in such cases reheating will become necessary at an earlier stage than when the temperature had remained above 900 deg.—which is economically a disadvantage. (2) When the shaping of the metal is really effected by cold work, done at ordinary temperature, the process is generally—unless a hard steel is wanted—finished by a reheating up to 650 deg. or 850 deg. As long as the reduction in cross-section exceeds the critical deformation of about 16 per cent., the strength of the metal will approximate that of a normalised metal. Should, however, the diminution in cross section fall within the critical range of 8 per cent. to 16 per cent., the steel will turn coarsely crystalline and will be very sensitive to shock; it may crack under blows and bending, though its general strength may be little affected. In many cases the critical range will not be avoidable in cold work as, for instance, when the steel is to be drawn accurately to a certain cross-section. In such instances, then, the range 650 deg. to 850 deg. is to be avoided, and since temperatures below 650 deg. cannot completely cure any ill effects of the cold work, reheating to above 900 deg. will be advisable.

On the other hand, the change in properties consequent upon the critical deformation may be desirable. This applies, for instance, to the shell bands, to which we referred in our introduction. The bands should not be hard and should have a low yield-point, lest they damage the rifling. The specifications for these bands demanded: Upper yield limit, if possible below 15 kg. per square millimetre (9·5 tons per square inch); breaking strength, maximum 30 kg. per square millimetre (19 tons per square inch); elongation at least 38 per cent; Brinell hardness maximum 80, if possible below 75. The bands were, by the last drawing operation, reduced in cross-section by from 10 per cent. to 15 per cent., and were then reheated to 800 deg.; most of the conditions of the specifications were fully satisfied by the steel produced, but the hardness nearly came up to the maximum permitted. The band, trapezoidal in section, was bent to a ring, then submitted to the final heating, and placed in its groove by sliding it over the lower part of the shell. In fixing the bands a swallow-tail groove was made in the shell, the groove being wider than the band; thus there remained a cavity on the one side of the band when placed in position, and a wire was squeezed into this and finished flush with the shell surface. Originally the band had been forced directly into its groove, but it had then been found to harden. (3) When we finally want a mild steel of high strength and great hardness, while of a certain diminished cross-section, the steel should be worked, not in the cold, but at about 200 deg. With a diminution in cross-section of 20 per cent., *e.g.*, rolling at 200 deg., instead of at ordinary temperature, would raise the breaking strength by 20 per cent. and the hardness by 15 per cent. These increases are, however, obtained at a sacrifice in impact strength, and in most practical cases the procedure will hardly be advisable.

Nitrogen Determination in Coal and Coke.—The three chief methods for the determination of nitrogen in organic compounds are: (1) The method of Dumas, in which the powdered substance is mixed with copper oxide in a combustion tube heated by gas flames and the nitrogen is collected as such; when certain complex nitrogen compounds are present, the combustion must be completed in a current of oxygen. A modification (1*a*) of this method by Simmersbach and Sommer makes use of an electric furnace. (2) The method of Kjeldahl, in which the nitrogen compounds are converted into ammonium sulphate with the aid of sulphuric acid and potassium permanganate. (3) The method of Will-Varrentrapp, in which the powdered substance is mixed with soda lime and heated in a combustion tube; the nitrogen escapes as ammonia. Method (3) being unsuitable for coal, E. Terres and collaborators recently (*Journal für Gasbeleuchtung* 12, pages 173 to 177 and 198 to 200) tried (1), (1*a*), (2), and they found in a coal respectively 1·72 per cent., 1·95 per cent., 1·52 per cent. of N. The discrepancies being too large they further tested the methods and observed, in confirmation of others, that (3) gives too small values unless certain precautions are adopted, and that (1), combustion with copper oxide followed by combustion with oxygen, remains on the whole the most reliable method.

The Diesel Motor-Ship "Zoppot."—The Zoppot, which was nearly finished in the Krupp Germaniawerft at Kiel before the war, and has in its recent completion undergone some improvements, is the biggest Diesel motor boat afloat. Originally known as the Wilhelm A. Riedemann, it was renamed Zoppot when it passed into the possession of the Balto-American Petroleum Import Company; it is now said to sail under the Danzig flag. The displacement loaded amounts to 22,000 tons, the weight empty to 17,000 tons, the gross burden to 9,700 tons. The corresponding figures of the British motor ship Glenogle, which comes next as to tonnage, are 19,600 tons, 14,400 tons, 9,150 tons. The length overall of the Zoppot is 165 m. (541 ft.), the beam 20 m. (60½ ft.), the draught 8·4 m. (27½ ft.). The two-cycle Diesel engines are of 4,400 h.p., the speed is 11·5 knots; at the trials 12·2 knots were recorded. The fuel consumption amounts to about 13 tons per day. In engine power and speed the Glenogle surpasses the Zoppot, the four-cycle engines of the latter being of 6,600 h.p., and enabling the ship, with a daily fuel consumption of 20 tons, to run at 14 knots. The two main motors of the Zoppot are six-cylinder engines, the cylinder diameter and stroke being 575 mm. (22·7 in.) and 1,000 mm. (40 in.); the speed was originally 106 r.p.m., but was, after the first sea trip, reduced to 102 r.p.m. The auxiliary engines and pumps are steam-driven, steam being raised in two boilers of 120 sq. m. and 160 sq. m. (1,290 sq. ft. and 1,720 sq. ft.) heating surfaces respectively. Except in the docks the ship is steered by compressed air. All the auxiliary machinery is, however, to be made electrical.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—Several factors contribute to make the return to normal conditions a slower process than in some quarters was looked for. Not the least of these is the shortage of coke. The heavy foundries maintained production throughout the coal strike at the expense of reserves accumulated over a very substantial period. Most of those reserves were practically wiped out, and although coal is forthcoming in fair quantities, its conversion into coke necessarily delays matters. When the foundries get going, a period of sustained activity is anticipated. Castings are still in brisk demand for all manner of engineering purposes. Arrears of orders are sufficient to keep staffs fully engaged for several months, despite repeated cancellations in the finished sections. There is also an improved call for certain types of light castings. In this connection it is noted that Messrs. Hadfields, Limited, are erecting another foundry which will provide work for 1,000 more men and furnish a weekly output of between 400 tons and 500 tons. The contraction of business in motor engineering is reflected in diminished activity in the rolling mills. As was the case last week, the mills will be working only four days this week. No improvement is looked for before Christmas. It may indeed be found necessary to restrict operations still further. That the undertone is healthy, however, is again indicated by the number of extensions that are being made to rolling plant. Several new mills are being built, and existing installations are under extension. The position in regard to crucible steel shows little change. Some inquiries are in circulation, but the amount of new business booked is not large. Trade in high-speed steel is slow, but inquiries are more numerous and an improvement is looked for. The market for steel alloys is undergoing a wave of depression. Prospects are not improved by the renewed importation of cheap foreign products. Foreign purchases of hand tools and implements continue on a very large scale. Plant is being installed on mass production lines, which should double Sheffield's output of certain classes of tools. Prices of raw and semi-finished materials show no change. There is no prospect of the big margin between hard and soft billets being bridged while foreign underquoting continues to exert a strong influence.

South Yorkshire Coal Trade.—Business is quietly getting into swing again. Manufacturers in the heavy trades could handle larger tonnages, but generally speaking there is no great pressure for supplies. The colliery position would be improved if there was a better supply of empty wagons. Coke is in heavy demand, and there is a strong run on nuts and best slacks. The house coal position is dominated by the seasonal change. Merchants are again booking heavy orders and are getting into arrears with deliveries. Quotations:—Best branch handpicked, 37*s.* 2*d.* to 38*s.* 2*d.*; Barnsley best Silkstone, 37*s.* 2*d.* to 37*s.* 8*d.*; Derbyshire best brights, 35*s.* 2*d.* to 36*s.* 2*d.*; Derbyshire house coal, 32*s.* 8*d.* to 33*s.* 2*d.*; Derbyshire best large nuts, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire small nuts, 31*s.* 8*d.* to 32*s.* 8*d.*; Yorkshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; rough slacks, 28*s.* 2*d.* to 29*s.* 2*d.*; nutty, 27*s.* 2*d.* to 28*s.* 2*d.*; smalls, 23*s.* 2*d.* to 24*s.* 2*d.*

Expansion of Glass at High Temperatures.—In our account of the recent discussions on "Colloids" we mentioned that Dr. Travers referred to experiments conducted at the United States Bureau of Standards on the dilatation of glass at high temperatures. These experiments were made by Mr. C. G. Peters and Mr. C. H. Cragoe on 32 different glasses, optical glass, chemical glassware and commercial tubing. A ring of the glass was placed between two plates made of fused quartz and heated in an electric furnace, the expansion being determined by means of the interference method of Fizeau; the temperature range was 20 to 650 deg. C. Up to a certain temperature the expansion was regular; then followed a critical range lying between 400 deg. C. and 575 deg. C. for the different glasses, and in this range the expansion increased to from two to seven times its previous rate. About 75 deg. C. above this range the glasses began to soften and to contract. The critical range coincides with the abnormal heat absorption previously observed by Tool and Valasek. Technically these observations are important especially with respect to the suitable annealing temperature and the range demanding very judicious cooling.

Thermoelectric Power of Pure Metals.—Experimenting with various thermocouples, made up by soldering wires of platinum together with wires of other metals, at temperatures from 0 deg. C. up to temperatures above the melting-point of the second metal, H. Pélabon (*Annales de Physique*, June last, pages 169 to 187) finds that the thermoelectric force varies continuously with the temperature and that there is no discontinuity at the melting-point of the second metal. The term "discontinuity," however, must not be misunderstood. In the case of Pt/Pb, for instance, the thermoelectric force is an ascending line which becomes horizontal at 325 deg. C., when lead melts. What is apparently meant is that there is no sudden rise or drop at the melting point, but the experimental data given do not show whether special care was taken to observe what was going on just at this point. In the cases of metals like bismuth and antimony, &c., which have a negative thermoelectric force, the curve slopes downward beyond the melting point of bismuth (268 deg. C.), &c. Other metals tested were tin, thallium, zinc, cadmium, nickel, copper, and the temperatures were raised to 700 deg. C. In some cases the thermoelectric curves agreed with the formula of Noll.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—The most outstanding feature in the Scotch steel trade this week is the reduction which has been made in prices. In the case of ship plates the minimum selling prices have been reduced by from 30*s.* to 50*s.* per ton, and for angles by from 40*s.* to 80*s.* per ton, both for delivery in Scotland. The quotations for black sheets have also been lowered. All these changes have been found necessary owing to the inroads which the foreign manufacturers have been making in our local markets, and to keep them from securing too large a hold on our home trade. Some time ago buyers became convinced that top prices had been reached, and ceased giving out orders, but producers, owing to the heavy oncost charges, coupled with the fact that their order books were well filled ahead, showed no inclination to shade prices. The matter of delivery was also a serious thing for the consumers as there was rather a long delay, and on account of the smaller output existing contracts were taking up nearly everything produced. The door for the foreigner was thus opened, and during the past month or two quite a considerable tonnage of material has been delivered in the Glasgow area. The Scotch steel makers have been considering the matter recently, and several meetings were held, one of which was with the producers of hematite. As the latter had made no indication of easier quotations the steelmakers endeavoured to secure some concession in the way of prices, but they were unsuccessful meantime, and at a meeting of the association held yesterday it was ultimately decided on their own account to make the reductions already mentioned. The following minimum selling prices were agreed upon, but no change was made in the price of boiler plates:—

	Current Price. Per Ton.	Reduction. Per Ton.
Ship Plates.	£ *s.*	£ *s.*
¾ in. and upwards	25 10	1 10
Under ¾ in. to 5/16 in. ...	30 0	2 10
Under 5/16 in. to ¼ in. ...	31 10	2 10
Angles, &c.		
7 united inches and over, &c.	24 10	2 0
Angles and bulb angles under 7 united inches	27 0	4 0
Tees and Zeds under 11 united inches	27 0	4 0
Flat bars under 8 in. wide ...	29 10	1 10
Rounds and squares under 3 in....	29 10	1 10
Channels under 6 in. by 3 in.	27 0	4 0
Boiler plates	31 10	—

All the above prices are for Scotch delivery. The various works are now running fairly full as the supplies of fuel are getting more plentiful and it is anticipated that the new price concessions will be the means of filling up order books. The Scottish Black Sheet Makers' Association have made reductions in their prices, and the following are the new quotations which came into force as from Monday of this week: *Black Sheets*—above 1/16 in. to under ⅛ in., 32*l.* per ton; 1/16 in. to ⅛ in., 32*l.* 10*s.* per ton; under ⅛ in. to 12 G., 32*l.* 15*s.* per ton; under 12 G. to 16 G., 33*l.* 5*s.* per ton; under 16 G. to 20 G., 33*l.* 10*s.* per ton; under 20 G. to 24 G., 34*l.* per ton; under 24 G. to 27 G., 36*l.* per ton. All these prices are net delivered Glasgow station or equal. Makers are well employed, but the coal strike has rather seriously disarranged the trade. Galvanised sheets are quiet.

Malleable Iron Trade.—The West of Scotland malleable iron makers are presently turning out a fair quantity of stuff, which is being readily disposed of against contract. The orders on hand both for the home trade and for export amount to quite a good tonnage.

Scotch Pig-Iron Trade.—A very steady demand exists for all grades of Scotch pig-iron, and whatever is being produced at present is in eager request by consumers. The output is very small as yet because of the coal strike, but every endeavour is being made to get the furnaces up to full heat for the higher grades of iron. The steelmakers are pressing for hematite. Prices are unchanged meantime, but there is a general feeling that a reduction may be announced in the near future although producers are disinclined to make any concessions at present owing to the high oncost charges.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Business in Cleveland pig-iron continues on a very limited scale. Scarcity of foundry kind, which is the description mostly needed, is so acute, that purchasing is almost impossible. The allocations to Scotland this month total only 5,500 tons, and it is doubtful whether the whole of this will be forthcoming. Any small parcels that become available are at once snapped up by home customers, and no effort is made to do foreign business, traders fully realising that attempt is useless. Forge, mottled and white are quite abundant, but home buyers are backward, and there is no demand for these qualities from abroad. For home consumption, No. 1 is 237*s.* 6*d.*, and No. 3, as well as all the lower qualities, stands at 225*s.*

Hematite.—There is practically no East Coast hematite to be had for early delivery, but makers are quite prepared to sell forward at current rates. Buyers, however, are disinclined to place orders ahead, and little business is passing. Mixed Nos. are 260*s.* for home use, 265*s.* for shipment to France, Belgium and Italy, and 270*s.* and upward for export elsewhere.

Blast Furnaces in Operation.—Most of the furnaces are in full blast again, but a few have not been able to resume work, the disposal of slag being the obstacle to the re-start. Owing to the tugboatmen's strike, the slag which has hitherto been dumped out at sea, cannot be taken away, and where the firms have no other means of disposal they have had to delay blowing in furnaces.

Foreign Ore.—More disposition to operate in foreign ore is noticeable. Though sales on early account are confined to disposal of odd cargoes, owing to there being little necessity to purchase for needs in the near future, signs of renewal of activity are shown by inquiries for delivery over periods next year. Market quotations are based on 50*s.* for best rubio, on the 17*s.* parity freight Bilbao-Middlesbrough, and present c.i.f. Tees value may be given at 52*s.*, as charterings from the Spanish ore port are being fixed at round about 19*s.*

Coke.—Coke is in heavy request, and good deliveries to local users are reported. Average blast-furnace kind is 62*s.* 9*d.* at the ovens, and quality low in phosphorus is 65*s.* 3*d.* at the ovens.

Manufactured Iron and Steel.—Reports of restoration of full activity at the various works after the enforced idleness through failure of the fuel supply, are gratifying. New business, however, is slow, and quotations for several descriptions tend downward, but there is some pressure for delivery of shipbuilding material. Common iron bars are 30*l.*; marked bars, 32*l.*; iron ship angles, 30*l.* 15*s.*; steel bars, 24*l.*; steel ship, bridge and tank plates, 24*l.* 10*s.*; steel angles, 24*l.*; steel boiler plates, 31*l.*; steel joists, 24*l.*; channels and flats, 24*l.* 5*s.*; rounds and squares, 26*l.* 10*s.*; soft billets, 22*l.*; medium billets, 23*l.*; hard billets, 24*l.*; heavy steel rails, 25*l.*; fish plates, 30*l.*; black sheets, 32*l.* 10*s.*; galvanised sheets, 36*l.* 10*s.*

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—It will be recalled that recently important suggestions were made to the Secretary of Mines by the District Coal and Coke Supplies Committee for South Wales involving a change in the present system of distribution in respect to the output of coal. In June last, in view of the fact that the coal production of the country was insufficient to meet the requirements of home and foreign consumers, it was decided by the Government definitely to limit the quantity of coal that was to be exported foreign as cargo from the United Kingdom to 21,000,000 tons per annum, the remainder of the output to be supplied to home consumers. This scheme has now been in operation six months, and has been responsible for a loss in production because of the inevitability of colliery stoppages, caused by inadequate transport facilities, delay in the return of wagons sent inland and in many instances by the fact that home consumers were unable to take further delivery and collieries unable to ship abroad. It was suggested to the authorities that instead of limiting exports the quantity of coal to be supplied to home consumers should be determined and allocations made on individual collieries, leaving the remainder of the output, after the allocations had been met free for disposal abroad. This it was contended would act as an incentive to colliery companies to increase output. The Secretary of Mines has, however, informed the South Wales Committee that he cannot adopt the suggestion, and the present system therefore remains in operation. Hopes that may have been entertained of a relaxation of the regulations governing the coal trade have been shattered by a new Order of the Coal Mines Department of the Board of Trade which takes effect from December 1 next.

Under this the export of coal, coke and patent fuel, as well as the supply of coal as bunkers for vessels proceeding to foreign destinations are prohibited. The coal that may be exported as cargo or supplied as bunkers is to be fixed and allocated among the different colliery companies by the District Coal and Coke Supplies Committee. Permits for shipment are to be obtained in the case of export to allied and neutral countries from the local representative of the Coal Mines Department, but if to enemy destinations, from the Controller's Department in London. In regard to foreign bunkers, vessels loading in South Wales, at the Mersey, and South Coast ports from Dover to Penzance, are to be exclusively supplied with South Wales coal. The provisions of the Order also apply to coke, briquettes and other solid fuel of which coal or coke is a constituent. Contravention of the Order renders liability to a fine.

Another Order cancels Clause 3 of the order of May 28, 1919, under which conditions were laid down respecting the sale of coal, coke and patent fuel to Holland and Spain. In these orders the minimum price applicable to Holland and Spain was expressed in guilders and pesetas respectively at a fixed rate of exchange of 12·11 guilders and 25·22 pesetas to the *l.* The effect of the cancellation of this clause is that in future coals sold in Holland and Spain will be at the current rates of exchange, and, incidentally, in view of the fact that the present rate between this country and Holland is favourable to the buyer and in the case of Spain against the buyer, as compared with the discontinued fixed rates, this makes British coals dearer in Spain and cheaper in Holland. Exports of coal from South Wales in the past week, at 88,000 tons, were double those of the preceding week, but 130,000 tons less than those of a normal week.

NOTICES OF MEETINGS.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, November 19, at 6 p.m., at Storey's Gate, St. James' Park, S.W.1. Paper to be read on "Sterilisation of Water by Chlorine Gas," by Captain J. Stanley Arthur, O.B.E., B.Sc., R.A.M.C.(T.F.).

THE STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Saturday, November 20, at the Education Offices, St. James'-road, Dudley. An Address will be given by the president, Mr. F. Somers, on "Some Impressions of his American Visit," to be illustrated with lantern slides. Chair to be taken at 6.30 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION MEETING.—Wednesday, November 24, at 6 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Address by Dr. W. H. Eccles, chairman of the section.

THE ROYAL SOCIETY OF ARTS.—Wednesday, November 24, at 8 p.m., "Colour Vision and Colour Blindness" (illustrated with lantern views of pictures by colour-blind persons, &c.), by Mr. F. W. Edridge-Green, C.B.E., M.D., F.R.C.S., Special Examiner in Colour Vision and Eyesight to the Board of Trade. Sir Philip Lloyd-Graeme, K.B.E., M.C., M.P., Parliamentary Secretary to the Board of Trade, will preside.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, November 25, at 6 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. "The Distribution of Electricity," by Mr. W. B. Woodhouse, and "Some Economic Aspects of E.H.T. Distribution by Underground Cables," by Mr. R. O. Kapp.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, November 26, at 8 p.m., at Caxton Hall, Lecturette, "Reinforced Concrete Coal Bunkers and Silos," by Mr. C. O. Mourant, Member.

AMERICAN STEEL IN ITALY.—According to *The Iron Age*, New York, Mr. Walter Bates, of the Bates Steel Trust Company, East Chicago, Ind., in an address before the Chamber of Commerce there, said that despite high prices paid to labour and other high cost of manufacture in the United States, the company is able to manufacture steel poles at its plant in East Chicago, ship them and sell them to its plant at Savona, Italy, for less than the raw material would cost in Italy. Mr. Bates is of opinion that United States concerns can get a lot of European business if they will go after it instead of waiting for it to come to them. Mr. Bates has just returned from Italy.

LAUNDRY AND ALLIED TRADES EXHIBITION.—On Wednesday last, Engineer Vice-Admiral Sir George G. Goodwin, K.C.B., LL.D., performed the opening ceremony of the International Laundry and Allied Trades Exhibition now in progress at the Royal Agricultural Hall, Islington, London, N. The exhibition, which was promoted by, and is under the direct control of the Society of Laundry Engineers and Allied Trades, Limited, is the first held since 1913, and it includes a representative collection of laundry machinery, appliances and supplies, many items of which are of considerable interest to engineers in general; we must, however, defer our account of these till our next issue. The organising manager of the exhibition is Mr. F. W. Bridges, and it will remain open until Wednesday next, the 24th inst.

MOROCCO.—The trade, industry and finance of Morocco are reviewed in a report (Cmd. 975) recently issued by the Department of Overseas Trade. As is well known, Morocco is divided into the zone under French protectorate, the zone of Tangier, and the zone under Spanish protectorate. The first zone, the one having the greatest area, is to the south of the country, and has been admirably developed, so far, under the energetic direction of General Lyautey, High Commissioner and Resident-General. We know from other sources that admirable harbour works have been in course of construction for several years past, at Casablanca, notably, by the Compagnie Marocaine, a French company of which Messrs. Schneider and Co., we believe, are the promoters. The report alludes to their activities in this respect. These works will greatly facilitate the export from the French zone of agricultural products, which appear, for the present, at all events, to constitute the principal source of wealth of the part of the country under French protectorate; the mineral resources are still undeveloped, but recent investigations have shown that there is a likelihood of important oilfields and extensive phosphate beds being exploited before very long. The resources of the international zone of Tangier, a comparatively small area to the north of the country, are also confined to agriculture. The principal crops grown include wheat and barley, but the amount produced is insufficient for the population, and both have to be imported in large quantities. The zone under Spanish protectorate is between the French and the Tangier zones, and has an extensive coast line on the Mediterranean, with main harbours at Ceuta and Melilla. In this part of the country, the presence of iron, copper, zinc, lead, silver and other minerals seems to be established without a doubt, but the unpacified state of most districts prevents European prospectors visiting the places from which specimens have been collected by natives. The only minerals being worked on any scale are in the vicinity of Melilla, there being several iron ore, lead and zinc mines. Besides these signs of mineral wealth, the Spanish zone has before it a good future as regards farming and stock-breeding.

PORTABLE ELECTRIC DRILLING MACHINES AT THE GLASGOW EXHIBITION.

CONSTRUCTED BY MESSRS. CAMPBELL AND ISHERWOOD, LIMITED, ENGINEERS, LIVERPOOL.

(*For Description, see Page* 678.)

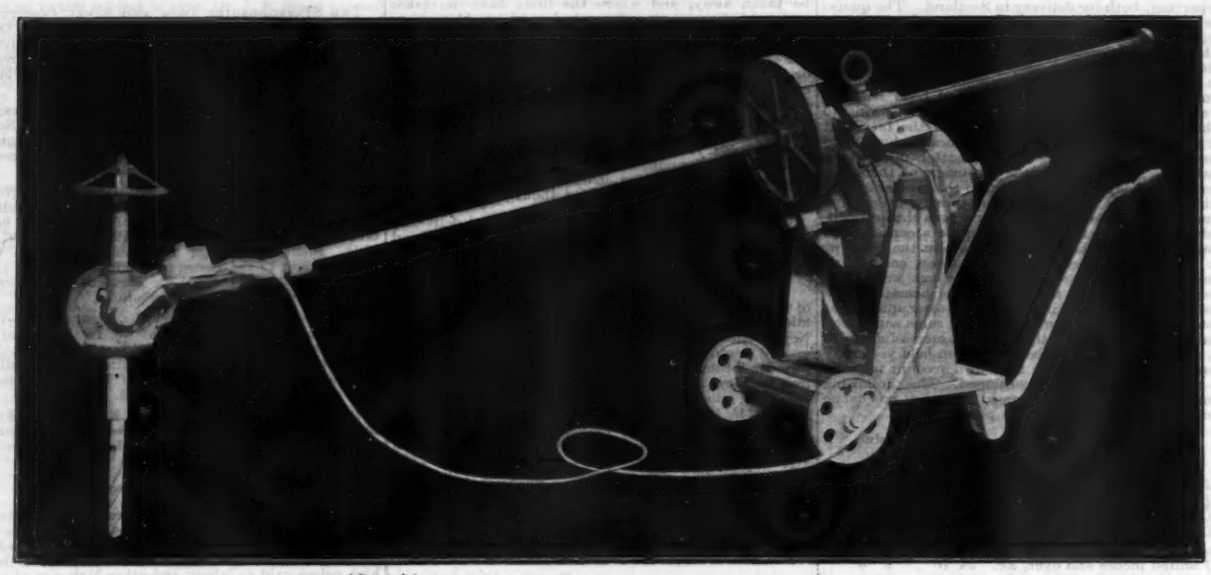
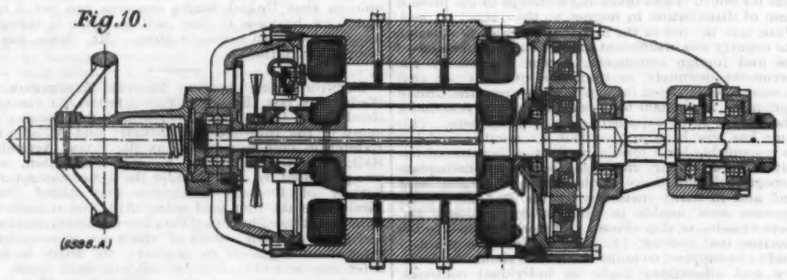
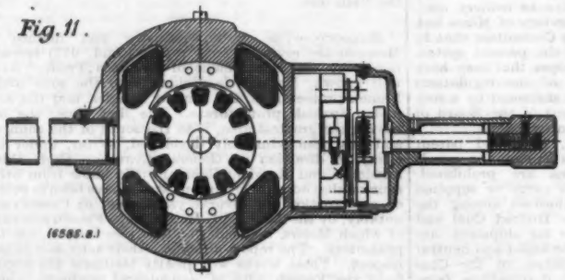
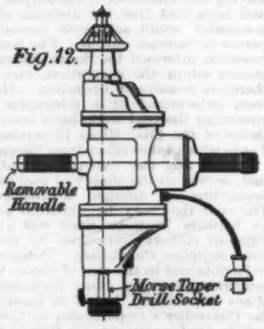


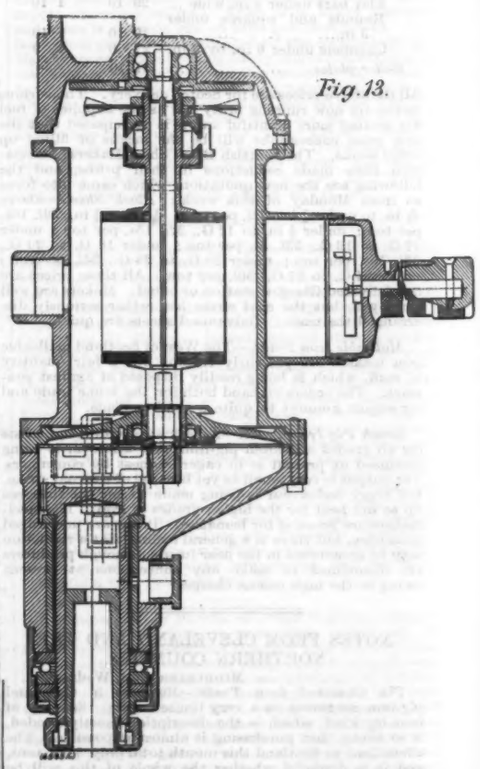
FIG. 9. PORTABLE ELECTRIC DRILLING MACHINE.







FIGS. 10 AND 11. ELECTRIC HAND DRILL. FIGS. 12 AND 13. OFF-SET ELECTRIC HAND DRILL.



ENGINEERING SOCIETY OF KING'S COLLEGE.—The Bishop of London, Chairman of the Council of King's College, has consented to take the chair at the twenty-third annual dinner of the Engineering Society of King's College. The guests of the evening will be Mr. Ll. B. Atkinson, M.Inst.C.E., M.I.Mech.E., President of the Institution of Electrical Engineers, A.K.C., and Mr. F. W. Macaulay, M.Inst.C.E. The dinner is to be held at the Connaught Rooms, Great Queen-street, tickets 13*s.*, on Friday, the 26th inst., at 7.30 p.m. Applications should be addressed to Mr. A. L. F. Simpson, or Mr. W. R. T. Skinner, King's College, Strand, W.C. The King's College London Old Students' Association, Engineering Faculty, will hold a general meeting at the Connaught Rooms on the same day, at 6.15 p.m.

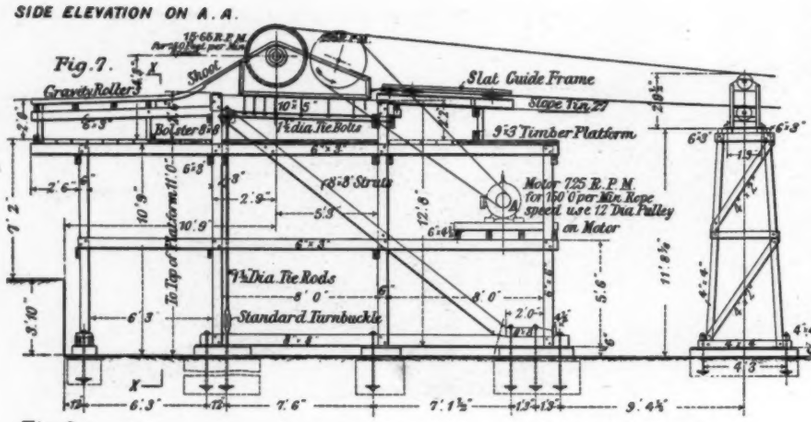
THE LATE MR. SIDNEY RICKMAN ADAMS.—We regret to have to record the death, which occurred at Abadan, Persia, on the 2nd inst., suddenly from heart failure, of Mr. Sidney Rickman Adams, the resident engineer of the Ridge Roasting Furnace and Engineering Company, 2, Great Winchester-street, E.C. 2. This company, who has advised us of the occurrence, states that Mr. Adams was for five years with Palmers Shipbuilding and Iron Company, Limited, and for three years with the London and South-Western Railway. He went to South Africa in 1893, where he designed and built plant for several mining concerns. Although over age, Mr. Adams joined up after the outbreak of war and quickly obtained promotion. He went to Gallipoli in the Royal Naval Division with the rank of Major. Later, he was sent to France with the Royal Engineers, and there suffered under one of the German gas attacks. On demobilisation he joined the staff of the Ridge Company, for whom he was resident engineer in charge of the erection of large plant at the works of the Anglo-Persian Oil Company, Limited, at Abadan.

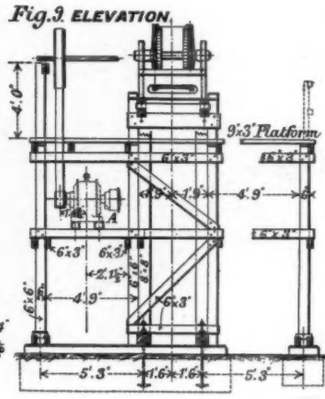
COAL IN JAPAN.—According to an estimate of the mining bureau of the Department of Agriculture and Commerce at Tokyo, says *Canadian Machinery*, Toronto, based mainly on coal veins over 2 ft. thick, and generally lying not more than 2,000 ft. below drainage level, the available coal deposits of Japan amount to about 822,000,000 metric tons. In addition, it is judged that approximately 2,940,000,000 metric tons, which lie at greater depths, can be mined if highly efficient methods are used. It is also surmised that the concealed and undetermined deposits of coal may possibly amount to 5,030,000,000 metric tons.

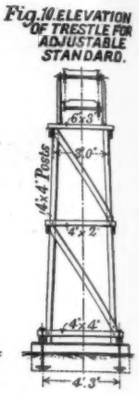
THE ROE CABLE

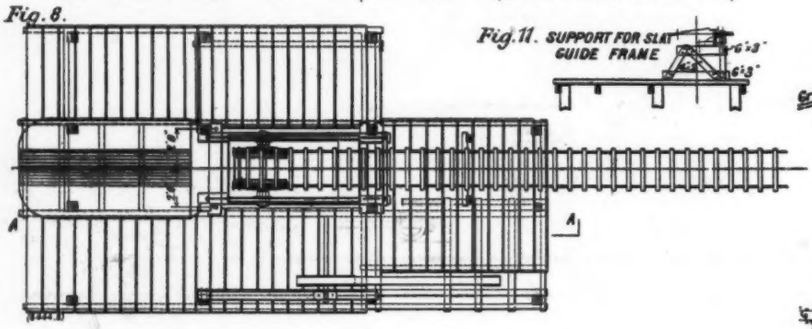
CONSTRUCTED BY MESSRS. ROPEWAYS, LI

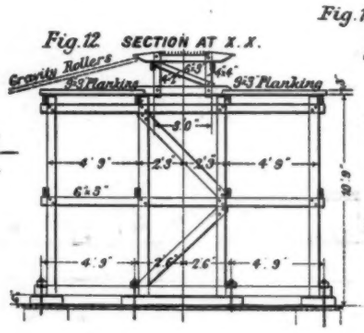
(For Descripti, see Pag

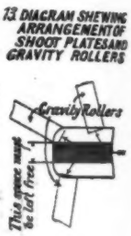


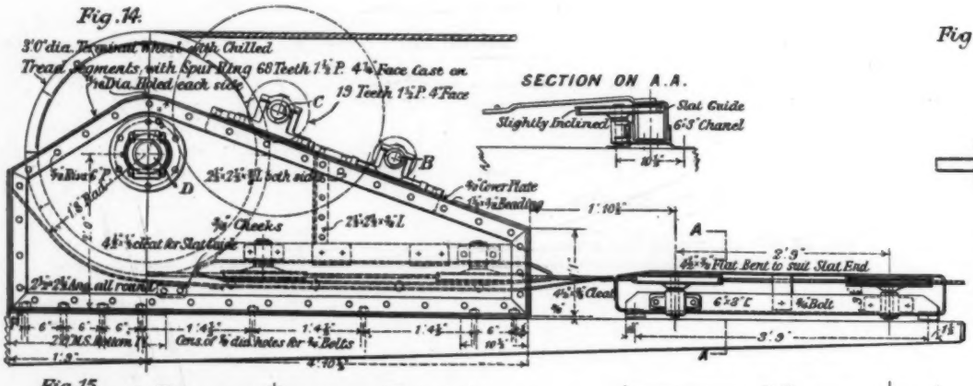


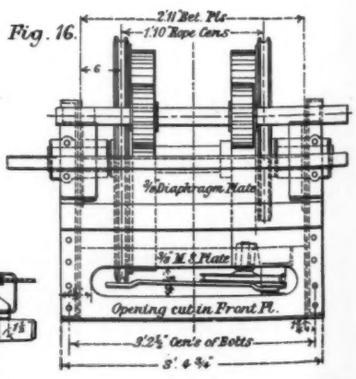


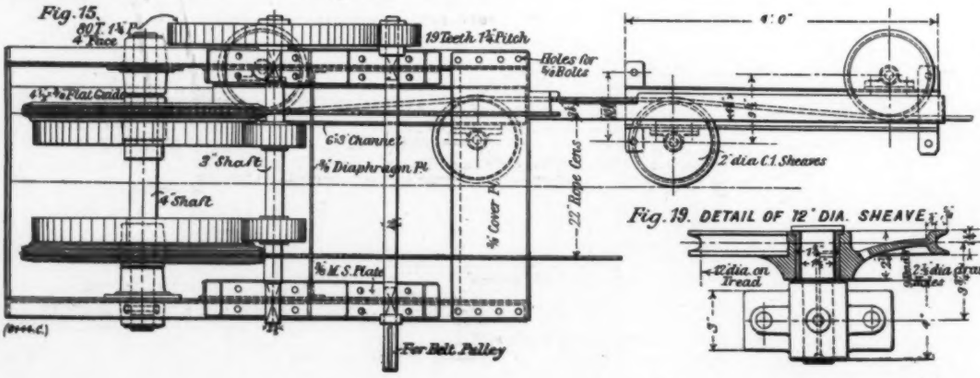


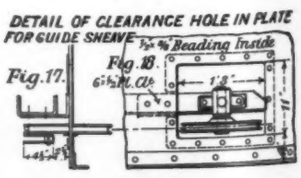












CABLE CONVEYOR.

ROPEWAYS, LIMITED, ENGINEERS, LONDON.

(For description, see Page 665.)

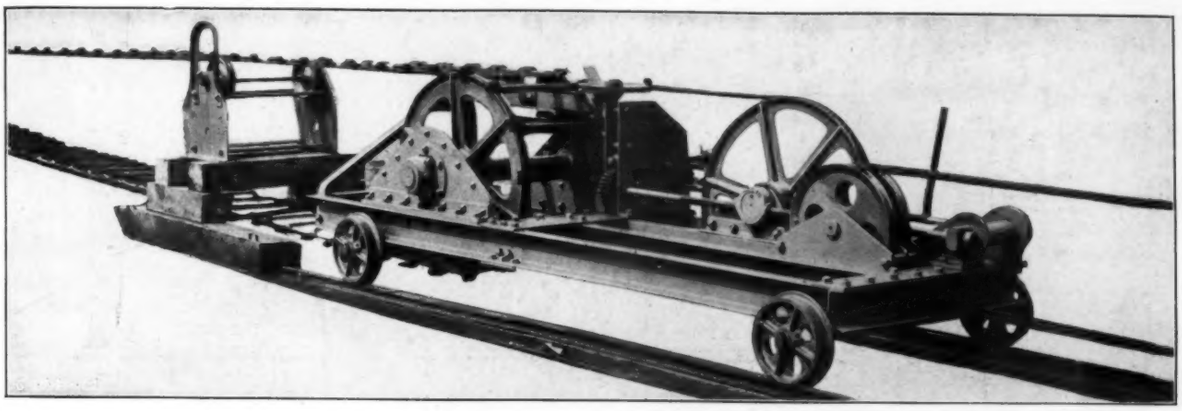
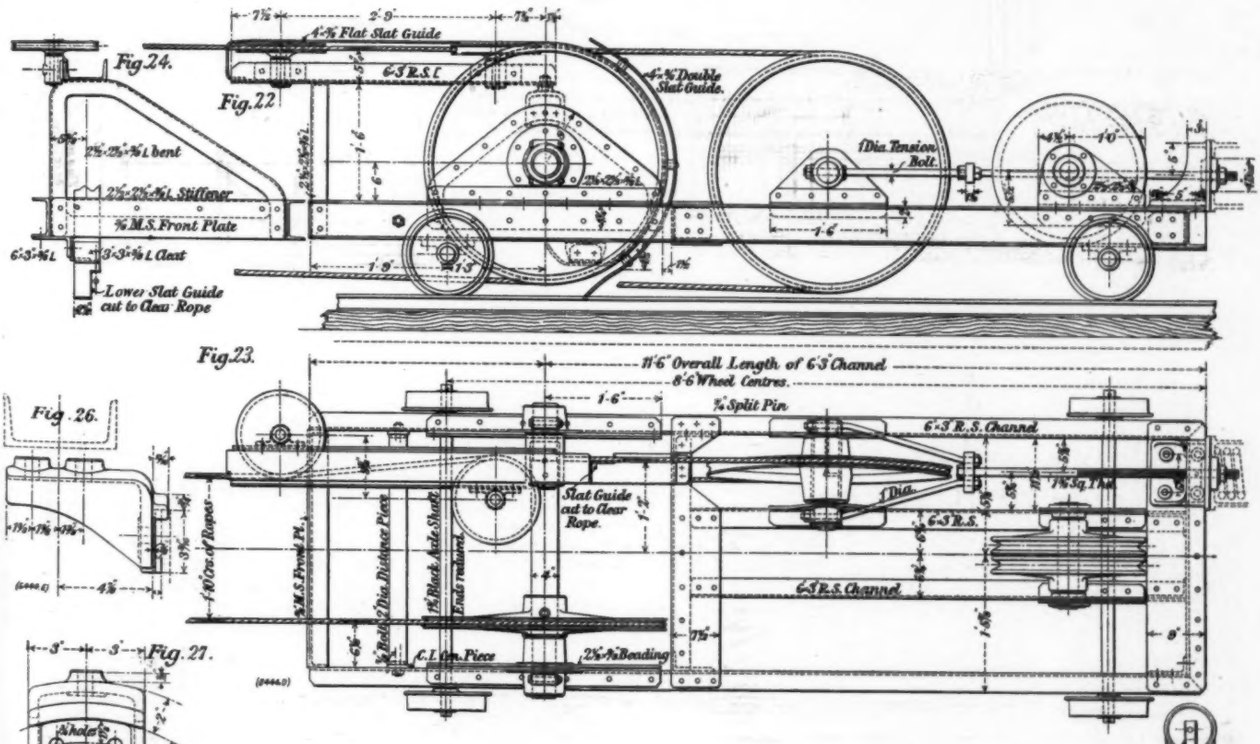


FIG. 21. TENSION TERMINAL.



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ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12s. per inch. Payment must accompany all orders for single advertisments, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

SUBSCRIPTIONS, HOME AND FOREIGN.

REVISED RATES.

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NOTICE.

A few months ago the Proprietors of "ENGINEERING" were compelled to advance the price of this Journal to 1s. per copy, owing to the enormous increases in the cost of paper, engravings and printing, &c. Now higher transport and delivery charges involve a further increase to 1s. 2d. per copy, and this price dated from and included the issue of Friday, April 2, 1920. As the postal rates have been again increased, the price of single copies sent by inland post is now 1s. 2½d.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions still imposed by the Government on the importation of paper and the consequent shortage of Supplies, Newsagents will not have copies for chance customers; therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 673.

ENGINEERING.

FRIDAY, NOVEMBER 19, 1920.

THE ENGINEER AND THE PUBLIC.

THOUGH modern civilisation rests mainly on the work of the engineer who furnishes transportation for personnel and material, provides us with water and light, and gets rid of our wastes, it cannot be said that he has hitherto played any prominent part in the conduct of public affairs. France, it is true, elected an engineer to the Presidency in the person of Carnot, but this example constitutes merely the exception that proves the rule. We have never had in England an engineer in the position of Prime Minister, nor, indeed, in any ministerial office until the tangle into which certain departments of Government had muddled themselves during the war made it imperative to call for the services of men of "push and go." As a consequence during the later years of this period of stress the engineer occupied a more prominent position in the public estimation than he had ever done before. It cannot be said that his advent was enthusiastically welcomed by the established authorities in either the civil or the military departments of State. The reluctance of the War Office to recognise that the trench warfare deadlock, predicted years ago by M. Bloch, could only be overcome by the aid of the engineer is notorious, but it is also true that even though admitted perforce into the Ministry of Munitions the engineer was so far as practicable, precluded from dealing with any but purely technical matters. He was, for example, excluded from the negotiations which took place on various occasions between the Ministry and the Trades Unions, and this exclusion of experts from the national side of these conferences was responsible for not a few of the labour troubles which afflicted the State during the latter half of the war. Like the country magistrate in the well known anecdote, the political heads of the departments found that to listen to both sides of a case had a confusing effect on their minds, and that it was simpler to accept the statements of the Union representatives as impartial and complete presentations of the matters at issue.

Simplicity is at times apt to prove expensive and undoubtedly did so here, and if the co-operation of the engineer continues in the future to be as distasteful to our public authorities as has commonly been the case in the past, the liquidation of our enormous war debt will prove far more onerous than it need be. As matters stand the public attaches far more weight to the utterances of the non-technical politician on technical matters than it does to those of the engineer. When the L.C.C. gave evidence before the Committee on London traffic its principal witnesses were not the able engineers in its employ, but the late Sir L. Gomme and the leader of a political party, both of whom gave completely erroneous evidence on highly technical points. The former, indeed, proposed to recast Newton's laws of motion, maintaining seriously that the heavier a body in motion might be the easier it was to stop it, whilst his colleague in an attempt to disprove that the tramcar caused more obstruction than the motor bus gave vent to views which, carried to their logical conclusion, implied that urban traffic would be best handled by long trains of coupled tramcars. Of course, no engineer could have been found to back either of these suggestions, but the marvel remains that such evidence was accepted as of a technical character by the Commission.

During the war much more weight came to be attached to the views of experts, but the innovation was by no means welcomed and the complaint was made that the committee which reported on electrical power distribution in this country did not include amongst its members aldermen and councillors. In America matters have been still worse, and Mr. Waddell, the eminent bridge engineer, records a case in which the position of county engineer was filled by a lawyer since it was held that the post must be filled by a politician whose peculiar qualifications are not fostered by the engineer's calling. Nevertheless, there has of late years been a strong movement in America to take certain public activities "out of politics." One method of doing this has been the adoption of the commissioner system, in which the direction of public works is entrusted to a small committee of experts appointed under conditions which render it difficult to over-rule or dismiss them. We believe that this plan was first adopted in connection with the State Railways in Australia, and proved of great service in preventing the construction of unremunerative lines under political pressure. In America and Canada the plan has also often proved highly advantageous, but according to Mr. Waddell a tendency quickly developed to make the appointments political, with the result that the last state of things has been worse than the first. Where the system has been fairly worked, however, excellent results have been achieved, and in some American cities at any rate, it is frankly acknowledged that the control of many public departments by engineers has been of very great advantage to the community. A serious obstacle to the engineer playing a more pronounced part in public affairs lies in the little interest taken by the public in the details of his work. When things go smoothly the success by which the public benefits is the only recompense of months or years of hard thinking. When difficulties arise it is commonly the practice to suppress all mention of them, even after they have been surmounted. Nevertheless, many dramatic moments arise in engineering operations which, if skilfully recorded, might help to raise the profession in the public estimation to something like the prominence now accorded to that of the law.

The general public, for example, is wholly oblivious of the devotion and courage shown in the earlier days of electric lighting by the engineers in charge of our power stations. Wellington never longed more earnestly for night or Blucher than did the station engineer for the time when the fall in the day's demand would allow him to cut out some machine which had unexpectedly developed faults, threatening at each moment a catastrophe, but kept running with a man stationed at the stop valve in the hope that "she'd last out over the peak." A most dramatic tale could be told of how the late Mr. Bryan fought to save the filters of the East London Waterworks Company from a sudden flood on the Lea. Men were obtained anyhow or anywhere to build up a protecting dam faster than the rising water. A brick yard was raided to supply the materials, and brick by brick the wall was raised. It was only after hours of anxiety that the flood began to fall and the security of the filter beds was assured. Had they been flooded the consequences might well have been an epidemic of typhoid. All protective measures had to be taken on the sole responsibility of the engineer, who incurred expenses running into hundreds of pounds without appeal to the directors. It is a curious commentary upon the public appreciation of the standing of its engineering experts that when appointed chief engineer to the Metropolitan Water Board Mr. Bryan was prevented by the regulations

from expending any sum exceeding £5 without first obtaining the sanction of the Board.

UNEMPLOYMENT INSURANCE.

On last Monday week, the 8th inst., the new Unemployment Insurance Act came into force. It makes no drastic changes in the principles upon which this form of insurance has been administered in the past, but it adds or will add very materially to the numbers of insured persons. In these circumstances it is obvious that a large number of new employers will be affected by the Act. They will naturally desire to know something about its administration, and it is important that they should do so, for they have it in their power to very materially assist the Ministry of Labour, whose duty it is to distribute the funds according to certain well recognised though little known principles.

A large number of people are possessed with the idea that unemployment pay is scattered broadcast, and that claims to be put on the fund are granted without any or any sufficient investigation. But this is not so. No person receives this grant unless certain statutory requirements are fulfilled; while a great many claims are subjected to judicial scrutiny. It is in the process of establishing such claims that employers can be of very great assistance.

Amongst the statutory conditions for the receipt of unemployment by an insured person is the following: "that he is capable of and available for work, but unable to obtain suitable employment." But a person is not deemed to have failed to fulfil this condition by reason only that he has declined an offer of employment in a situation vacant in consequence of a stoppage of work due to a trade dispute or (generally speaking) that he has refused to work in the district where he was last ordinarily employed at a rate of wage lower or on conditions less favourable than those which he habitually obtained in his usual employment in that district, or would have obtained had he continued to be so employed. If he is offered work in another district, he is entitled to the wage generally observed in that district. The act makes special provision for cases in which employment is lost through strikes. Generally speaking, a man put off because he is a striker, or because there is a stoppage of work in the factory due to a strike of other workmen, is not entitled to benefit. This rule is subject to certain exceptions where separate branches of work which are commonly carried as separate businesses are carried on in separate premises. Finally, an insured contributor who loses his employment through his misconduct, or who voluntarily leaves his employment without just cause may be disqualified from receiving benefit for more than six weeks.

It will be realised from what has been said above, that a variety of questions may arise when an insured person seeks to come on the fund. When he makes his claim, it is investigated, in the first instance by the "insurance officer" who will generally communicate with the applicant's last employer in order to ascertain why the applicant ceased work. The insurance officer may also have to consider whether the applicant has been refused suitable employment.

If he decides against the applicant, an appeal lies to a Court of Referees consisting of an employer's representative, a workman's representative, and a chairman appointed by the Minister of Health, who may allow or disallow the claim, subject to a further appeal to an umpire. The applicant is always summoned to appear in person before the Court of Referees.

In the course of these enquiries certain questions may arise with regard to which the testimony of the employer may be of considerable importance. In the first place "Did the applicant lose his work through misconduct?" The employer will generally be asked to state in writing the reason why the applicant was discharged, and he will greatly facilitate the work of the insurance officer or the Court of Referees (as the case may be) by giving his reason as fully and completely as possible. A man's vague assertion that the man was dismissed for "unsatisfactory conduct" or "misconduct" is of little value, and only necessitates further correspondence. Some employers are naturally reluctant to put anything against a man's character into writing; but communications made for the purpose of helping the administration of this Act are privileged and are not disclosed to the applicant. It has occurred more than once to those who have to decide these cases that the reasons for dismissing every insured person should always be reduced into writing (*e.g.*, entered in a book) by the employer so that a reliable account of what took place may be forthcoming if required. Again, some employers are reluctant to state the real reason for discharging a man because they fear he may be deprived of benefit. But it does not follow that because a man has been dismissed, the Court of Referees will hold him guilty of "misconduct" within the meaning of the Act. For example, a man was employed by certain contractors who were working for the General Post Office. It having come to the notice of the Post Office that he had been convicted for theft many years before, the contractor was called upon to dismiss him and did so. Yet it was held that there was here no misconduct which should deprive him of benefit.

The next question upon which the evidence of the employer can be of material assistance to a Court of Referees is—Did the applicant leave voluntarily without just cause? The addition of the words "without just cause" make it plain that mere voluntary leaving does not necessarily disentitle a man to claim benefit. He may be able to show that the conditions of labour were such that he was justified in leaving or that the employment was dangerous to his health. A few examples culled from cases decided by the umpire may suffice. Where a disabled soldier had been employed as a ground attendant for two years at 14*s.* left his job to find other employment, it was held that he was justified in doing so.

Again a non-unionist who was compelled to leave by unionists was held not to have left voluntarily without just cause. Similarly where a tool setter employed as such for three years refused to work as an operator, he was held not to have left his employment voluntarily without just cause. At the same time the workman must show that he had just cause, and the employer can very materially assist the investigation of the matter by placing on record the reason why every man leaves his service. A few examples may be given, but it should be remembered that each case is decided on its own facts, and it is difficult to lay down any very general principles. It has been held *not* to be just cause for leaving:—

(*a*) That applicant was asked to work overtime on urgent work; (*b*) that a labourer was asked to unload lorries; (*c*) that a workman was asked to carry goods affected by a strike; (*d*) that a man left his work which he had done before the war, to make way for discharged soldiers; (*e*) that applicant has a better job in view which he fails to get.

The cases just referred to were decided in relation to out-of-work donation, which is administered on principles similar to those upon which unemployment insurance is paid.

The importance of the employers being able to give assistance on these points lies in this that, generally speaking, the Court of Referees never has the employer present to give evidence. They have to rely upon such information as he may give them in writing.

Finally, it may be observed that in helping the Ministry of Labour to administer the Act employers are doing a service to the State, to insured persons and to themselves. The unemployed fund is not so large as to be able to bear any strain in excess of that to which it should properly be subjected.

COLLOIDAL FUEL.

Fuel problems and colloidal problems are so much to the front at present that the papers on "Colloidal Fuel," brought before the Institution of Petroleum Technologists last Tuesday, were sure of an appreciative reception. The subject had only been alluded to last month during the general discussion on "Colloids,"* and that was just as well; for there would not have been time for an adequate treatment of these special important problems. But Sir Frederick Black, the President of the Institution, had referred at previous meetings to colloidal fuel, with the promise of which he had become impressed while in America on a war mission. One can hardly speak of any colloidal fuel industry, even in America, so far; a little has been done on the Continent, nothing over here. But England will have an opportunity to see what is being done; the demonstration plant for colloidal fuel processes and products, now nearing completion at Stone Court on the Thames, will help to keep the interest alive. The two papers on "Colloidal Fuel" read, but hardly discussed, last Tuesday, both came from New York, and they formed practically a joint communication. Mr. Lindon W. Bates lectured on the general aspect of the problems; Mr. Haylett O'Neill, his assistant, added details, tables and curves—peculiar curves—to explain the Properties and Characteristics of Colloidal Fuel. The Stone Court plant is their undertaking.

Mr. Bates opened his lecture by the words: "When the fiat came forth 'Let there be light,' it started the three elements in which man is most concerned on courses of endless change, born of their attachment to each other—hydrogen, carbon and oxygen." There was a good deal more of this resounding phraseology in his lecture—enough almost to prejudice one against his cause. Mr. Bates had originated the term "colloidal fuel," and had defined it for the "Century Dictionary" as follows:—"A stable, mobile, atomisable fuel displaying colloidal characteristics, comprising particles of solids, droplets of liquids or minute bubbles of gases, or combinations, suspended in one or more varieties of liquid hydrocarbons"—a definition more suitable for a patent specification than for a dictionary. Attempts to prepare combined coal-oil fuels go back further than the war, during which Mr. Bates was in charge of the United States steamer Gem, assigned to the Submarine Defence Association. The difficulty was, of course, to secure stability of the suspensions of powdered coal in oils, for storage as well as for use within a given temperature range, and in the passage of the fuel through the pipes, preheaters and burners, in which neither settlement and clogging, nor partial unmixing must occur, nor sinking of the heavier particles or rising of the lighter constituents to the surface.

When the fuel is to be burnt immediately, a stability of a few minutes would suffice, but such cases are rare. Stability for a month or two will meet most requirements, and that, Mr. Bates stated, could be secured, sometimes with the aid of occasional agitation. Mr. Bates indicated three methods—not necessarily the preferred methods, as he remarked. Particles could be stabilised, firstly, by the use of certain protective substances such as soap or a lime-resin-grease; the latter would act also on coarse particles of more than colloidal dimensions. Bituminous coal and some other solid carbonaceous substances could, secondly, be stabilised by the addition of coal distillates and tars of middle fractions, the mixture being afterwards submitted to a heat treatment below flash point. Thirdly, stabilisation was facilitated by intense grinding.* Mr. Bates likened the colloidal fuel plants to cement plants. The ordinary coal-pulverising mills first used had been replaced by single and double Fuller coal-pulverising ball mills; at present the Smidth, Marcy or Newell combination tube mills were considered superior, especially owing to their adaptability to liquid grinding of coal in oil. A very suitable fuel consisted, *e.g.*, of 30 per cent. of coal, 10 per cent. of coal tar distillate, and 60 per cent. of fixated mineral oil; but up to 55 per cent. of foreign substance could be stabilised in mineral oil.

Mr. H. O'Neill gave the annexed table of the components and characteristics of colloidal fuels. He considers all the heavy petroleum oil imported into this country as usable for this purpose, a cut-back or thinning oil being added if necessary. In certain cases tar products might serve as principal liquid; fuel had been made from crude oil and wax tailings, thinned with pressure-still oil or tar; carburetted water-gas tar was also serviceable as cut-back. The solids might be coal, coke, charcoal, hard pitch and any grindable carbonaceous

* See Engineering, October 29 and November 5.

* Compare the article on the Colloid Mill, Engineering, October 1, page 429 *ante*.

material; the solid should be ground so that about 97 per cent. would pass through a 100-mesh screen, and at least 85 per cent. through a 200-mesh screen. The amount of inert incombustible matter had little effect upon the combustion efficiency.

As regards the proportion of particles likely to settle Mr. Bates stated that the first colloidal fuel of the Gem carried 31 per cent. of Pocahontas coal in navy fuel oil, and was used and tested for five months. At the end of three months the small settlings were again stirred into oil. The grade 15, carrying 38 per cent. of mixed coal and coke in fixated Mexican oil, had destabilised 2·6 per cent. of its particles in five months, still displaying Brownian movements then. Grade 16 (42 per cent. of mixed coal and coke in Mexican oil) was used eight months after manufacture, having been stirred in barrels exposed to frost and weather without any treatment than the coil heating necessary to remove the material from the barrels. The United States National Board of Fuel Underwriters certified that the colloidal fuel was practicable for ordinary burning like fuel oil; that it was not affected by sea-water, nor probably by any chemical reactions with the steel or iron tanks; that salt water and high temperature had no apparent effects; that the flash point was much higher than the flash points of the usual fuel oils and the ignition point also high; there was no tendency to spontaneous ignition, and the fire hazards were hence moderate, and smaller than with oil of flash point 150 deg. F. to 180 deg. F. The composites containing 15 per cent. of coal being heavier than water, Mr. Bates added, any flames could be quenched by water, which would float on the top, and the oil could be—and was—stored and safeguarded under water seal; sprinkler systems of fire protection did not lose their utility as they did with oil fuel. The flash-points of most colloidal fuels ranged between 250 deg. F. and 280 deg. F.

Colloidal Fuel Components and Characteristics.

Typical Examples showing Principal Components only in Round Numbers.

Example.	Paraffin Base Oil.	Asphaltic Base Oil.	Pressure Still Oil.	Wax Tailings.	Coal Tar.	Middle Fraction Coal Oils.	Road Oils.	Anthracite Coal.	Bituminous Coal.	Coke.	Fuel Specific Gravity.	Fuel Flash-point (Open Cup).	Fuel B.Th.U. (per lb.).	Viscosity (Deg. Engler), 70 Deg. to 100 Deg. F.	Suitable Preheat.	Stability (Minimum at 70 Deg. F.).
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.		deg. F.		deg. E.	deg. F.	
A	70	—	—	—	—	—	—	—	30	—	1·03	240	17,100	170	150	3 months
B	—	—	35	—	20	10	—	—	35	—	1·12	250±	17,000	350	160	3 months.
C	10	—	37	3	—	—	10	38 (25, ash)	—	—	1·15	300+	15,300	200	150	10 days.
D	10	30	30	—	—	—	—	—	30	—	1·08	266	17,200	67	150	4 months.
E	8	—	50	—	10	2	—	—	30	—	1·04	262	16,650	452	180	4 months.
F	—	60	4	—	—	—	—	—	18	18	1·05	273	16,900	—	180	6 months.
G	—	54	4	—	—	—	—	—	21	21	1·08	280	16,700	—	180	8 months.

Mr. Bates also explained how it came about that the good grades of colloidal fuel possess more thermal units per volume than either of its principal components separately; Mr. O'Neill granted that a coal of 13,000 British thermal units mixed with an oil of 18,500 British thermal units would only give, in mixtures of 35 : 65, a fuel of 16,575 British thermal units. Both emphasised that the advantage gained was a question of increased density, since more heat would be obtained from the pound of fuel. These density gains, and the lowering of the specific heat of the colloidal fuel, 0·4 against an average specific heat of the oils of 0·5, were demonstrated with the aid of curves and diagrams, each of which bore the signature of both the gentlemen—exercises in the rule of three, as Dr. Ormandy subsequently called them. If Mr. Bates and Mr. O'Neill really think that the specific heat of a mixture is merely the algebraic mean of the specific heats of the constituents, one can understand their making some of the statements of the paper; but these statements do not rise in value. It may be that a colloidal fuel evaporates less and has a lower flash point than the oil itself, owing to some selective adsorption of the volatile constituents by the carbon particles; but we want experimental data on that. Practically the viscosity curves alone seemed to be based upon actual determinations. Mr. Bates further mentioned that on the Gem the existing oil-firing equipment and the Normand boilers had been used without any substantial change; he also stated that with preheating up to 160 deg. F. or 220 deg. F., according to circumstances,—through higher temperatures were required for Mexican oil—several varieties of mechanical and steam burners were being used, and that the land boilers at Greenpoint, New York, had practically not needed any preliminary mechanical adjustment. Mr. O'Neill admitted that there had been some carbonising at the 1·7 mm. burner tops, though little more than with ordinary oil. He also pointed out that moisture, which is very disturbing in ordinary oil, was far less troublesome in colloidal fuels. Any water present was so completely emulsified during the manufacture that the rolling of the ship would not separate it again; there had been no separation in a large tank which had been rocked for several months. Electrolytic precipitation by contact with sea-water would not take place either; this is remarkable, since electrolytes frequently precipitate colloids, but Dr. Ormandy doubted whether the coal is really in the colloidal condition in these fuels. One advantage claimed for the colloidal fuel, that it could, by the act of freezing mixtures, be turned into a tough gel which would serve as an armour plating, caused some amusement.

Mr. Haylett O'Neill spared the meeting none of the many reiterations of Mr. Bates' paper when reading his own communication, even when he approached the suggested time for adjournment within a few minutes. There was practically no time left for discussion, and the few remarks made by Mr. Anfilogoff, Dr. Ormandy and Professor J. S. S. Brame were possibly a little more pointed and less reserved than they would have been under other circumstances. The speakers agreed that the papers should not be published, and thus indirectly be endorsed by the Institution, without some protest against the general claims not substantiated by sufficient facts. As to cost the meeting was only informed that the cost of manufacture of a ton of colloidal fuel was about 6s. Nobody complained that no further information was given on that head. That cost is not essential at present; but the manufacture is only one of several items, comprising preheating, distribution and installation. If colloidal fuel really promises material advantages, a better utilisation of inferior coal and a general saving of valuable oil fuel, everybody is willing to give it a trial. But we must obtain some advantage by combining the two fuels, and we must have real experimental figures. Diesel engines were mentioned. A Diesel engine will put up with a great deal, but not with mineral impurities in its fuel, and one feels generally sceptical as to spraying any fuel containing mineral through fine burners. It is quite likely that the combustion of the fine carbon particles is almost explosive and as instantaneous as that of oil spray; that is not the main point at all for the whole new range of new fuels of which Mr. Bates spoke. Whether or not the carbon particles are merely very small, but not really colloidal, matters only in so far, as we cannot credit mere mechanical suspensoids with the properties of colloids, their stability in the first instance. In closing the meeting Sir Frederick Black announced that they would have to devote a special evening to the discussion of the colloidal-fuel problem.

EGYPT.

In the past we have recorded from time to time the progress of development which has resulted from the British occupation of Egypt. It has been our boast, as a nation, that we have brought prosperity out of bankruptcy in Egypt in a manner which has certainly astonished not a few people in the world. Whether we shall be permitted to complete the work to which we thus at first unwillingly put our hand, is likely to be decided before long, but the indications, such as they are, appear to point to a considerable reduction of British assistance in advisory and executive directions. A rather unique interest, therefore, attaches at the moment to Field-Marshal Viscount Allenby's report on that country, and on the Soudan, recently published, which covers the five years ending with 1919, thus closing with the period when we might have hoped that the development, suspended during the war, would have been resumed on lines having continuity with those of the previous period. Unfortunately, this has not been possible, and the future alone can prove whether the country is as far advanced as one section of the nation believes, in its ability to continue the work we are asked to lay down.

Generally speaking, the commencement of the war saw Egypt slowly recovering from a rather disastrous period. The war itself, while it brought all sorts of difficulties in its train to a country which is wholly dependant on others for manufactured articles, brought a great deal of money into Egypt, not only in payment for the cotton and other crops, but also as pay to the troops, much of which was at once spent locally. The result has been an unprecedented accumulation of wealth, and a rapid rise in the cost of living. The latter is reflected in the work of all the government departments, while the 48 hours' week has been recognised in some of the administrations, tending further to put up the cost of operation. In the budget for 1920–21 a large sum was put aside for the purchase of new rolling stock. The railways generally suffered rather badly during the war, having to help out the military system run out to Palestine and Syria, and during that period no new stock was procurable, while all reserves were used up. The cost of operation is now more than twice what it was per train kilometre in 1914. Similar high costs are reflected in the figures for the Port and Lights Administration, and the Roads and Bridges Department. New departments have been created for dealing with motor transport and inland navigation. The former has been formed with the object of centralising the control of Government vehicles, repairing them and organising running supplies, &c. The Inland Navigation Department has taken over the regulation of all river traffic. This, we believe, is a direct outcome of the war, when the railway services were so curtailed that transport suffered badly until organised on the river to supplement the remains of the railway service. In former years there have been many interesting incidents in the history of the river and the railways in Egypt. Probably now advantage will be definitely taken of the river for traffic for which, in some respects, it is particularly well suited. A scheme of river improvements is being drawn up.

It would take too much of our space to review all that was done by the public services of the country during the war. Generally the facilities and assistance they were able to offer were fully utilised by the British military authorities. The Administration of Ports and Lights had to deal with an enormously increased naval traffic at Alexandria. No less than 11,250,000 tons of transport shipping made use of that port, and warships amounting to 807,000 tons. Over 8,000,000 tons of transport shipping passed through the Suez Canal, in addition to which about 1,400 vessels representing transports, colliers, hospital ships, &c., were dealt with at Port Said. The port workshops, the railway workshops and the technical schools were all engaged on military work, while

the latter supplied a number of apprentices to Army workshops, and it is interesting to note that they were found to be satisfactory in these rather unusual conditions of employment.

A few years ago the water supplies of the towns of Egypt were in anything but a satisfactory condition. Now no less than 23 towns have now either filtered or well supplies. The filtration plants vary between the Jewell, Puech-Chabal, sand and mechanical types, the two largest being Jewell plants at Cairo and Alexandria, dealing respectively with 60,000 and 50,000 cubic metres per diem. Again roads, which a few years ago scarcely existed, now amount to over 3,700 km. in length, though it is not stated what class of traffic these will bear. Drainage, too, is receiving attention in the larger towns, the latest to be interested in schemes of this class being Suez and Mansourah.

In irrigation, which is the source of Egypt's existence, various changes have been made in recent years. Though the larger programmes have not progressed at the pace expected when they were inaugurated before the war, smaller works have been continued where possible. These have included economising the supply of water by re-modelling several of the canal outlets to dimensions proportionate to the areas served. This has not only saved water, but has reduced the risk of over-watering, which in the past has done so much damage to the crop returns. The Assouan dam has had the chance of proving its great value in several of the recent years when it has enabled the normal discharge of the river to be doubled. The large drainage and reclamation works inaugurated in the Delta in 1912 were suspended during the war. On the other hand, in 1917 preliminary work was carried out on the Sennar dam on the Blue Nile, and the Gebel Aulia dam on the White Nile. The latter, it is estimated, will form a reservoir nearly twice as large as the Assouan dam, and is intended to provide for some 1,900,000 acres of waste land in Egypt under perennial irrigation, and for the perennial irrigation of 1,200,000 acres now under basin irrigation. The Sennar dam is intended to irrigate the Gezireh, south of Khartoum, an area as large as the Delta. Some progress has since been made in preliminary work, such as quarrying, &c., but the schemes have lately formed the subject for an investigation by the Niles Projects Commission.

In 1917 the Government undertook to erect for the Soudan Government, in the provinces of Dongola and Berber, a number of pumping plants for selected isolated areas. It is understood that these have proved successful. Another interesting instance of successful lift irrigation has been the Government station at Abu Menâga, north of Cairo. This station is operated by electricity supplied by the Heliopolis Oasis Company, and it is stated that cultivators can now irrigate at a cost of 15s., what it costs several pounds to irrigate elsewhere in the same neighbourhood.

The Soudan, which has not been troubled with any wave of restlessness such as has passed over Egypt, has fluctuated in recent years, but development has only been seriously interrupted in the outer districts by small disturbances, while the country materially assisted in the war, notably by partaking in the movement by the King of the Hedjaz in 1916, &c. The reports, on the whole, are good, though they show in some cases recession from high figures of 1917 and 1918. The period covered by the report has been a trying one, complicated not only by the war, but by a variety of seasons, some of which have been far from good, so that the outcome may, on the whole, be considered satisfactory.

NOTES.

Wireless Message Printing in Ordinary Type.

A demonstration illustrating the fact that to an increasing extent wireless telegraph apparatus is being adapted to most of the services performed by ordinary telegraphy, was given at the inaugural meeting of the session at the Royal Society of Arts last Wednesday evening. The occasion was an address by Mr. A. A. Campbell Swinton who, for the third year, holds the office of Chairman of the Council of the Society. In view of the fact that he had already given two inaugural addresses, Mr. Campbell Swinton filled this third occasion by a short discourse on recent wireless developments and illustrated it by experimental demonstrations. Of these latter that of greatest interest was certainly the reception of wireless messages in the hall and their reproduction in ordinary type by the Creed printing telegraph instrument. The news service sent out from the Admiralty Station, Horsea, near Portsmouth, was picked up and printed, as also a special message despatched from the Eiffel Tower by the co-operation of General Ferrié, the head of the French military wireless service. The Creed printing telegraph has been employed for many years in connection with ordinary telegraph service and is in fairly extensive use by newspapers and similar organisations, but this was the first occasion on which it had been publicly shown in operation in connection with wireless. The instrument which receives the Morse message records it by perforating holes in a paper tape, and this tape is afterwards passed through a printing machine which prints a second tape in ordinary typewritten characters.

Physical Properties of Nickel-Iron Alloys.

Professor L. R. Ingersoll and various collaborators of the University of Wisconsin have investigated the physical properties of nickel-iron alloys, containing from 1 per cent. up to 90 per cent. of nickel, the alloys having been prepared by Professor Burgess and submitted to mechanical and electric tests. The two metals were both pure electrolytic products and were melted in a magnesia crucible to obtain ingots about 1 lb. in weight which were machined into bars; the carbon percentage was about 0·1. In most cases the properties underwent decided changes when the nickel percentage was between 30 and 40; the well-known alloy invar contains 35 per cent. of nickel. As regards specific heat thermal conductivity and electric resistance, iron and nickel do not differ much from one another; the curves for the alloys hence came back to practically the same levels after having risen or fallen. The specific heat of alloys varied between 0·116 and 0·123, and the rise to the maximum (for the 35 per cent. alloy) and fall from it was very marked. In the case of the thermal conductivity, the curve descended sharply at first, then more slowly from 0·14 to 0·03 as the nickel percentage increased to 30 per cent.; but the minimum between 30 per cent. and 40 per cent. was not at all well defined, and the subsequent rise was very slow. The thermo-electric power curve had the shape of an M, the 35 per cent. alloy occupying the characteristic position corresponding to the apex of the angle between the two bars both of which were sloping, to unequal degrees. The relative minimum pointed out was already observed by Haken in 1910. When the electric resistance was plotted as a function of the temperature, the resistance increased, of course, as the temperature was raised from 0 deg. C. to 700 deg. C., at temperatures up to about 400 deg. C. The rise to the maximum resistance of 35 per cent. alloy was again very strongly marked; but at higher temperatures the peaks and the whole curves became more flat. The low-grade alloys also showed secondary maxima which were absent from the high-grade alloys. That the law of Wiedemann-Franz, according to which the thermal and the electric resistances of the same metal are proportional to one another holds approximately at any rate for the alloys, can be seen from the curves; but the fact was not rigorously established, because the two sets of measurements were not made on the same specimens. The general conclusion to be drawn is that the 35 per cent. alloy, corresponding to the formula $Fe^{1}_{2}Ni$, differs from the other Fe-Ni alloys; it has the highest melting-point, highest specific heat and smallest thermal conductivity and thermoelectric power of the alloys, and its specific resistance is greatest and the temperature coefficient of the resistance lowest.

British Production of Pig-Iron and Steel.—The production of pig-iron and steel which had been 741,000 tons and 884,700 tons respectively in September, fell in October, owing to the coal strike, to 533,200 tons and 544,300 tons respectively.

THE SHIPBUILDING, ENGINEERING AND ELECTRICAL EXHIBITION AT GLASGOW.

(*Continued from page* 637.)

We indicated last week that there was a considerable electrical display at Glasgow. A large proportion of the heavier electrical firms have not participated in the exhibition, but in spite of this the display in general is of much interest. It is, however, perhaps rather as illustrating the way in which electrical apparatus has penetrated into every branch of engineering rather than in set electrical displays that the interest lies. Almost the only show of the heavier type of electrical generating plant is, we think, made by Messrs. Bruce Peebles and Co., Limited, of East Pilton, Edinburgh. As Messrs. Bruce Peebles are probably the largest electrical manufacturers in Scotland, it is fitting that they should be prominently represented. Their chief exhibits consist of a 1,500-kw. 25-cycle rotary converter, which is one of 12 similar sets being supplied to the Glasgow Corporation, and a 500-kw. 50-cycle Peebles-La-Com motor converter which is one of six being supplied to the Mersey Docks and Harbour Board. This latter machine is, of course, of a type with which Messrs. Bruce Peebles' name is especially associated. The firm also show a 40 brake horse-power slip-ring type steel works motor, of a type supplied to the Lanarkshire Steel Company, as well as various standard industrial motors.

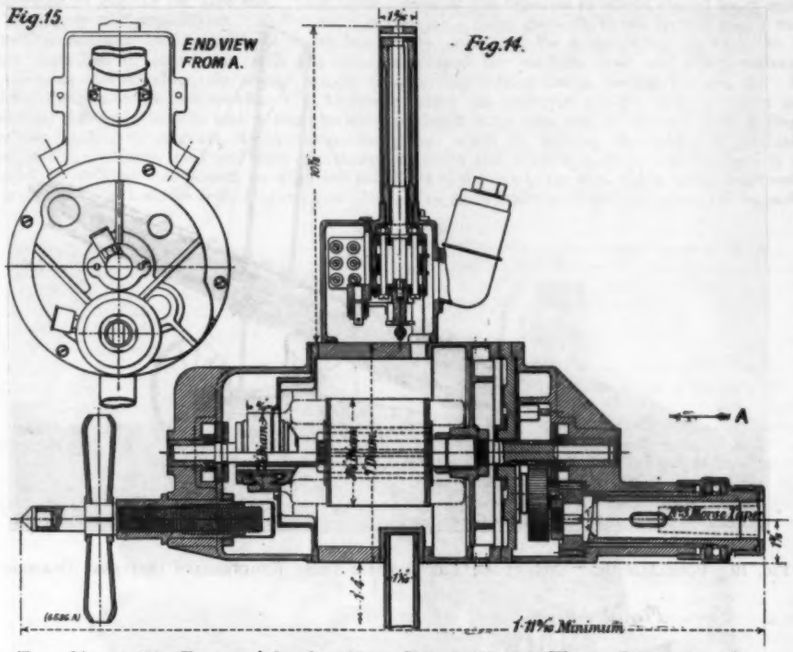
A prominent electrical stall is also occupied by the Corporation of Glasgow Electricity Department. This is naturally mainly devoted to domestic electrical appliances, which are to some extent outside our province. In view of the importance of the purpose for which it is intended an electric milk sterilizer may, however, be mentioned. The operation of sterilising milk is a simple one, consisting essentially in raising it to a temperature of about 160 deg. F. and maintaining it at that temperature for, we believe, 20 minutes. As a consequence the apparatus is a simple one. It consists of a lagged galvanised iron tank fitted with heating elements inside and on the bottom. A grating covers the elements and the cans of milk stand on it. To carry out the operation the tank is partly charged with cold water, and the cans of milk are placed in position. The heating elements are then switched on and maintained until the suitable temperature has been reached. The elements are arranged to be separately controlled so that 160 deg. may be maintained without being exceeded. A high temperature which would scald the milk is undesirable. Taps are provided so that when the operation is completed the tank may be flooded with cold water to cool the milk.

The paper-mill driving gear shown by the Harland Engineering Company, Limited, of 66, Carrick-street, Glasgow, we described and illustrated last week. This firm exhibits, in conjunction with the British Electric Plant Company, Limited, of the same address, and various motors, switch gear, electrical mining plant, &c., are shown. Electric control gear is represented by an extensive display of contractor panels and similar material by the Igranic Electric Company, Limited, of 50, Wellington-street, Glasgow, and Bedford. This firm's work in this particular line of electrical material is well known. Electric mining switch gear, coal cutters and underground conveyors are shown by Messrs. Mavor and Coulson, Limited, of 47, Broad-street, Mile End, Glasgow, while an excellent display of their overhead trolley gear, current collectors for cranes, &c., is to be seen on the stand of Messrs. Brechnell, Munro and Rogers, Limited, of Thrissell-street, Bristol. This stand is of much interest as illustrating the quality and variety of products which this firm manufactures for use in connection with current-collecting problems. In connection with auxiliary electrical gear we may also mention the exhibit of oil-switch panels, iron-clad gear, &c., shown by Messrs. Ferguson, Pailin, Limited, of Openshaw, Manchester.

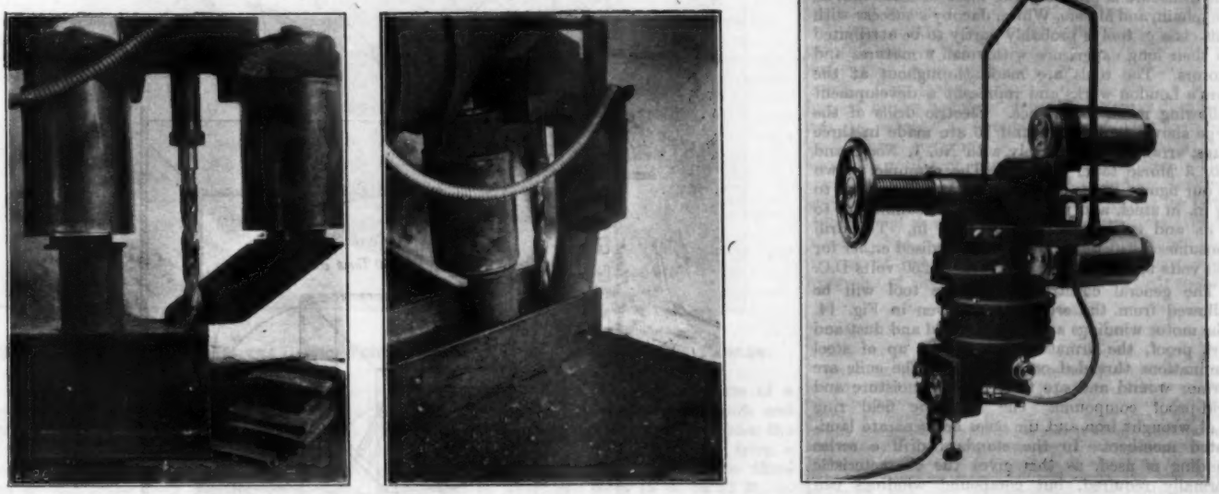
Portable tools both of the pneumatic and electric types are shown on a large number of stalls, and as we are dealing with electrical apparatus we may here refer to some of the electrical

examples. One of the most distinctive tools falling within this class is the portable electric drill manufactured by Messrs. Campbell and Isherwood, Limited, of Raleigh-street, Bootle, Liverpool, and Argyle-street, Glasgow. This machine is not a novelty, as it has been made by the firm for several years, but has not before been illustrated and portable drill head by a sliding shaft. The drill head has a practically universal movement around the end of the shaft, so that it may be set up in any position in a drill stand, behind a shore, or in any other such way as the conditions of the job may render convenient. The sliding shaft may be moved along its mounting on the motor for its full in any position. The drive, as will be seen, is from a pinion on the armature shaft to the spur wheel through which the sliding shaft is carried. This sliding shaft has proved very satisfactory in practice. It gives a solid drive, and its simplicity and absence of joints makes it compare favourably with flexible transmissions. The shaft is slotted for almost its full length for the driving feather, and at its outboard end a detachable taper coupling unites it to the drill head. The coupling can be locked to prevent it from being inadvertently detached. The drill drive is through bevel gearing, and ball-thrust washers are fitted to take the drilling thrust. The switch is mounted on the drill head and connected to the motor through a flexible cable, so that the movements of the drill may be controlled from alongside it. A grinding attachment is also made in connection with this machine, consisting of a flexible shaft connecting to the end of the armature spindle. A grinding wheel in a hand holder is carried at the end of the shaft.

In addition to this special tool Messrs. Campbell and Isherwood also manufacture the more normal type of portable electric drill, and details of some of their patterns are given in Figs. 10 to 13 on page 674. The tool, the cross section of which is given in Fig. 10, is the second size which the firm build. It is capable of drilling up to $\frac{7}{8}$ in. diam. with a feed of 2 in. and weighs 30 lbs. The larger and smaller sizes drill respectively up to $1\frac{1}{4}$ in. diam. and $\frac{5}{8}$ in. diam. The tool, as will be seen, is of the centre spindle type. The motor has a compound characteristic and is weather proof and fan ventilated, air being taken in at the commutator end through apertures covered with fine mesh gauze and ex-



Figs. 14 and 15. Electric Off-Set, Hand Drill; Messrs. White, Jacoby and Co., Limited, London.



Figs. 16 to 18. Portable Magnetic Drill; Messrs. White, Jacoby and Co., Limited, London.

described in our columns. The appliance may be looked upon as holding a position midway between the fixed drill and the electric hand drill, and possesses some of the advantages of both. In adaptability to awkward situations and in the facility with which it may be used on erected, or partly erected, work, it has most of the qualifications of the self-contained electric drill of normal type, but as against this form of tool there are no conditions pressing towards undue weight reduction in the motor. There are no reasons why the electrical parts of the tool should not be of the most robust construction and equivalent in every way to the similar parts in a fixed tool.

The main features of the appliance are clearly to be seen from Fig. 9 on page 674. It consists of a motor mounted on a carriage and connected to a length, so that within these limits the drill may be set up at any distance from the motor. The upper part of the carriage can swing completely round on the base. For working a position in which the carriage would be an inconvenience or not required, the motor is arranged so that it can be easily disconnected and can be used when suspended. The tool is made in three sizes, the smaller having a 1 h.p. motor and the larger a 3 h.p. The smaller machine will drill up to $1\frac{1}{4}$ in. diam. and the larger up to 3 in. The example shown in Fig. 9 is of the single-speed type, but the machine is also built with a three-speed gear box which is mounted on the motor frame end below the spur wheel.

The machines are built either for direct or alternating current, and the motor is completely enclosed and weatherproof. It is arranged to work hausted at the gear-wheel end through similar spaces on the magnet ring. The gearing is of planetary type enclosed in a grease-tight case, and ball bearings are used throughout, as will be seen from the cross section. The dull spindle has a No. 2 Morse taper socket and is arranged so that the feed pressure is taken by the ball-thrust washers contained in the outer housing of the gear case. The cotter-hole lies between this outer housing and that of the inner bearing. The outer housing is connected to the main body by three ribs. The feed screw has an Acme thread and is fitted with a hardened centre, under which is a collar and plain shank forming an end for working in a tee slot. Each machine is supplied with a breast plate which may replace the feed screw. The switch case is cast *en bloc* with the magnet frame, and the cover forms a handle

through which a spindle passes connecting the switch to a knob at the end. The knob is of slightly greater diameter than the handle to facilitate operation. A small turning movement, which can be made without releasing hold, switches the motor on or off. The arrangement of the switch and its operating mechanism is well shown in Fig. 11.

Our other illustrations on page 674, Figs. 12 and 13, show the firm's new off-set pattern of portable electric drill, that is, the pattern in which the drill spindle is out of centre with the motor case. This arrangement increases the usefulness of the tool by allowing it to drill holes close up into corners. The drill shown in cross-section in Fig. 13 is the largest pattern made and is capable of drilling holes up to 1¼ in. diam. The distance from the centre of the drill to the side of the case is 1⅜ in. In the smaller sizes this dimension is respectively 1 1/16 in. and 1 1/16 in. The general details of the off-set drill remain as in the concentric pattern already described, but the gearing is, of course, modified as shown in Fig. 13. Another valuable alteration which has been made in this pattern is also shown in this figure. This lies in the introduction of a loose drill socket carrying a Morse taper in place of the taper being formed direct in the spindle. The object of this is to avoid the rough handling which the spindle is apt to receive in the workshop or the yard owing to the cotter for driving out the drill being forgotten or mislaid. In these circumstances, it is quite common practice to attempt to remove the drill with a file tang or the first object handy, with the result that the socket gets badly knocked about. The introduction of the loose socket eliminates this cause of trouble.

A portable electric drill, manufactured by Messrs. White, Jacoby and Co., Limited, of Bayham-place, Camden Town, London, N.W.1, is illustrated in Figs. 14 and 15 on page 679. This firm has been engaged in the manufacture of electrical machinery for 27 years and has specialised on small armature work. A successful portable electric drill demands good design and workmanship in all its parts, but the armature is probably the most delicate link in the chain, and Messrs. White, Jacoby's success with this class of tool is probably partly to be attributed to their long experience with small armatures and motors. The tools are made throughout at the firm's London works and represent a development following much experience. Electric drills of the type shown in Figs. 14 and 15 are made in three sizes, arranged respectively with No. 1, No. 2 and No. 3 Morse taper sockets. The example shown in our figures is the largest size. It will drill up to 1¼ in. in steel, and may be used for reaming up to 1 in. and tube expanding up to 4 in. The drill consumes 2,640 watts and is standardised either for 100 volts to 120 volts or 200 volts to 250 volts D.C.

The general construction of the tool will be followed from the cross-section given in Fig. 14. The motor windings are fully enclosed and dust and dirt proof, the armature being built up of steel laminations threaded on the shaft. The coils are former wound and are treated with moisture and acid-proof compound. The magnetic field ring is of wrought iron and the poles are separate laminated members. In the standard drill a series winding is used, as this gives the characteristic normally required, but compound windings can be fitted if desired. Carbon brushes are used and the brush holders are carried on a ring, which is independent from the top cover, so that the cover can be removed without disturbing the brushes. A flat type of brush spring is used. Forced ventilation is provided and the air circulates through the commutator and armature coils. The gearing consists of two reductions, the wheels being steel with generated teeth. They are enclosed in an aluminium alloy case and a lubricating chamber is formed by a diaphragm which isolates the gear from the motor case. Glands are provided to keep the motor winding free from oil and grease. The bearings are of high quality phosphor bronze, and a compound ball bearing and thrust is fitted at the top end of the armature spindle. A ball thrust is provided for the drill socket. The switch is of the double-pole contact type with positive on and off positions. It is operated by rotating the side handle. Connection is made to the drill by a three-point non-reversible plug, the third point carrying the earth connection.

It will be quite clear from our figures that the drill has an off-set spindle. All the electric hand drills built by the firm are, we believe, constructed in this way. The arrangement obviously increases the utility of the drill by allowing it to be used in corners and at the same time does not interfere in any way with its normal use in places where there is plenty of clearance. The tool shown in Fig. 14 is fitted with a feed screw for use in connection with a drill post, but the standard equipment also includes a spade handle and breast plate. The No. 3 size drill which we illustrate, weighs 60 lb., the two smaller sizes weighing respectively 35 lb. and 26 lb. This type of electric drill is of great convenience for a large class of work and is coming into very extensive use. Used as a hand tool, particularly in the small sizes, it would probably be impossible to find anything else more convenient or lending itself to more rapid work. For heavier work a drill stand is useful in relieving the workman and increasing the speed of work, and if a magnetic stand is used the process of setting up becomes one of rapidity and ease. In order, however, to still further economise speed of setting up and to enable work to be dealt with which does not always allow of the convenient mounting of a drill post, Messrs.

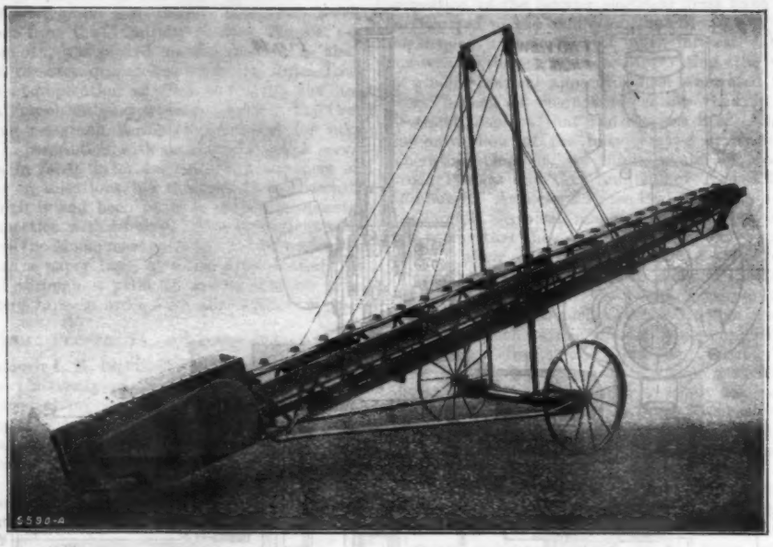


FIG. 19. PORTABLE BELT CONVEYOR, THE RITCHIE-ATLAS ENGINEERING COMPANY, GLASGOW

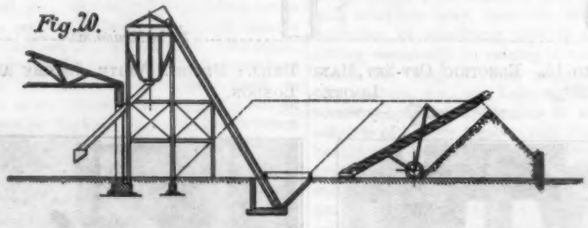


Fig. 20.

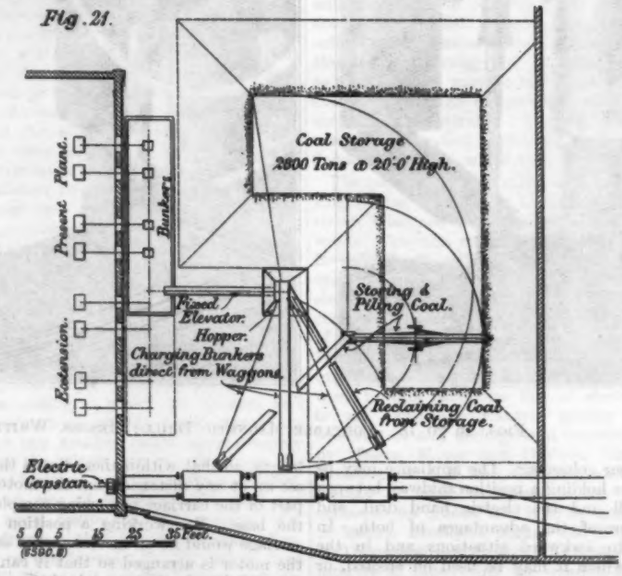


Fig. 21.

FIGS. 20 AND 21. WORKING LAY-OUT FOR PORTABLE CONVEYOR.

White, Jacoby have introduced a type of portable drill which embodies the features of the class we have already described, but, in addition, contains its own magnetic holding-on gear, so that no drill post or other external arrangement to take the thrust is necessary.

This magnetic drill, as it is termed by the makers, is illustrated in Fig. 18 on page 679. This figure will be largely self-explanatory. The details of the drill mechanism follow largely those we have already described in connection with the other type, but, as will be clear, the motor spindle is set at right angles to the drill spindle. The feature of essential difference in this tool is the provision of the two holding-on magnets, which sustain the weight of the appliance itself and take the thrust produced by drilling. As shown in Fig. 18, the drill is supended in a bridle from a crane, but this feature is only introduced to facilitate the movement from one drilling position to another. When in operation the drill sustains itself. The convenience of this tool will be obvious, and in drilling, for instance, a joist set vertically, the drill may be lifted by the crane from position to position, and when it reaches each, all that is necessary is to switch in the holding-on magnets, when drilling may be immediately commenced. With the magnets resting on a reasonably flat surface the tool holds on with a pull equivalent to a weight of 644 lb., but even when the full holding-on area cannot be utilised a sufficiently powerful grip to enable the tool to work is obtained. Two interesting views showing the employment of the tool in awkward situations by means of packing pieces are given in Figs. 16 and 17. The total weight of the drill is 242 lb. It is fitted with a No. 3 Morse taper socket and is capable of drilling up to 1¼ in. diameter in mild steel at the rate of 1½ in. per minute.

An appliance which is of particular interest at the present time in view of the increased cost of labour of any kind is shown by Messrs. The Ritchie-Atlas Engineering Company, of 109, Hope-street, Glasgow. This takes the form of a portable belt conveyor, which is illustrated in Fig. 19, on page 680. The handling of loose materials in transit sheds, coal yards, &c., is one which lends itself very well to the use of mechanical appliances, but in very many cases the scale, or intermittency, of the work make the cost of installing overhead crane services or complicated conveyor systems, prohibitive. In many such cases a portable conveyor of the type we illustrate should be of much service. Being portable, it can be used over a very large area, and its adaptability allows it to be employed for stacking coal and other material, removing it from stacks, loading vehicles, &c. By rotating the conveyor around its lower end a surprisingly large area can be stacked from a single point, while by moving the conveyor gradually sideways and loading it from vehicles there is no limit to the size of the area which can be dealt with.

The main features of the appliance will be easily followed from the illustration. It consists of a belt conveyor carried on a lattice framework and driven by a self-contained electric motor from the bottom end. It is also built for driving from a petrol engine. The conveyor is made in three widths and in lengths of from 15 ft. to 51 ft., in increments of 3 ft. Somewhere about the mid-length of the conveyor there is a two-wheeled carriage with two upright posts. The lattice frame is hung from these posts by wire ropes and a small winch is fitted on the axle by means of which the inclination of the conveyor may be varied to suit the work in hand. The carriage wheels are arranged so that they may be swivelled until they lie at right angles to the centre line of the machine. As the lower end of the conveyor is carried on a castor, the swinging of the wheels into this position easily allows the whole appliance to be transported sideways. By swinging the wheels until they make an angle with the conveyor it will be clear that the machine may be swung around the castor as a pivot.

In addition to the inclined conveyor, as shown in Fig. 19, the appliance is also built as a horizontal conveyor running on castors, and a combination of the two types enables storing and stacking operations of very many kinds to be carried out. An arrangement of plant of this kind is got out for a generating station, for dealing with coal, is illustrated in Figs. 20 and 21, on page 680. As will be seen a railway siding, with an electric capstan for hauling up the wagons, lies on one side of the coal store. The coal arrives on this siding, and when charging bunkers it is carried by a horizontal Ritchie-Atlas conveyor direct to the foot of the fixed elevator. When storing and piling coal the same portable horizontal conveyor feeds a portable inclined conveyor. The figure shows the area which may be covered in this way. When reclaiming the horizontal portable conveyor feeds the fixed elevator, leading to the bunkers, as shown.

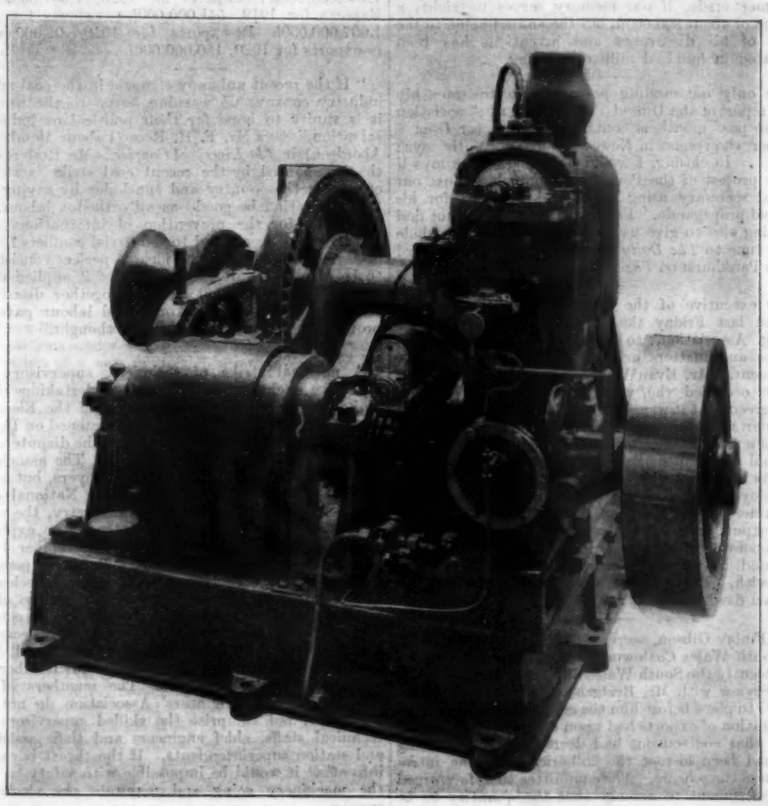


Fig. 22. 20-Cwt. Oil Engine-Driven Cargo Winch; Messrs. Thomas Reid and Sons, Paisley.

In our issue of last week we illustrated two examples of oil-engine driven winches, and in Fig. 22, annexed, we show a third example. This is constructed by Messrs. Thomas Reid and Sons, of Thread-street, Paisley, and is driven by an 8-h.p. paraffin engine manufactured by Messrs. Petters, Limited, of Yeovil, Somerset. The winch is of 20-cwt. capacity, and will lift this weight on a single rope at 62½ ft. per minute. It will lower, or run in the reverse direction, at 119 ft. per minute. The drum is 9 in. in diameter, and warping drums, 9 in. diameter at the waist, are fitted at each end of the barrel shaft. Control is by means of a hand lever at the front side of the winch. When moved to the right this lever engages a clutch for lifting, and when moved to the left engages another clutch for lowering under power, or for running the drums in the reverse direction. With the lever in the mid-position the engine runs free, and the weight may be lowered by gravity, being controlled by the foot-operated band brake.

The engine shaft carries two sets of gearing, each fitted with a double internal friction clutch. This gearing and the gearings on the first-motion shaft, have machine-cut teeth. The main spur wheel on the drum is of cast-iron and is driven by a cast steel pinion. The Petter engine is of the two-stroke cycle type. It is built to run on paraffin. Starting is carried out on petrol and a small chamber is provided which is filled before starting and carries sufficient petrol to get the engine away. The paraffin tank is fitted in the bedplate of the winch, and supply to the engine is by a small reciprocating pump. The jacket water is drawn from a tank formed in the bedplate of the winch, and does not run to waste, a circulation being maintained. A flywheel governor is fitted and regulates the speed by acting on the fuel and air ignition. The complete winch is a very workmanlike looking article, and should prove of much utility for both ship or land work. The Glasgow representatives of Messrs. Thos. Reid and Sons are Messrs. Munro and Young, of 143, West Regent-street, Glasgow, and examples of Reid winches are shown on their stand.

(To be continued.)

Are all the Elements Radioactive?—People no longer doubting the reality of the decay of some of our chemical elements rather ask why that radioactive decay should so strangely be limited to a very small number of the elements. Though one might retort that radioactive decay, if a common property, would hardly have remained undetected for ages, it is also true that the detection requires most delicate methods, previously unknown, and that the suspected small radioactivity of most elements would be very difficult to establish. Engaged in such researches, G. Hoffmann, of Königsberg (*Annalen der Physik*, August 20 last, pages 738 to 758), made use of an exceedingly sensitive electrometer and of a sphere of brass (consisting of two bored hemispheres, bolted together, 7·2 cm. in diameter), very highly evacuated in the first instance. From the known ranges of α particles it can be decided by elaborate statistical methods, whether the activity is due to members of the radium or thorium families. Any α particles present in the residual gas or in the metal walls would ionise the gas by direct collisions or by reflection from the walls of the sphere. It resulted that the ionisation observed in air and in carbon dioxide could not fully be accounted for by any known radiations, and there must hence be some additional undetermined radioactivity, possibly of the copper in the brass. In order to modify the experiments cages of platinum wire were suspended within the sphere (to reduce the area of the reflecting wall) and the gas pressure was raised to 15 atmospheres. Other very open wire cages were used in larger vessels of zinc and of rock salt. The conclusion is that there are really very feeble undetermined radioactivities, in the case in question probably due to an element having a life period $1 \cdot 5 \times 10^{6}$ times longer than that of radium.

THE LATE MR. WILSON HARTNELL.

It is with much regret that we record the death of Mr. Wilson Hartnell, which took place at his residence, Aysgarth, Roundhay, Leeds, on the 10th inst., in the eighty-second year of his age. Mr. Wilson Hartnell's name is familiar all the world over in connection with his pioneering work on steam engine governors. He was elected a member of the Institution of Mechanical Engineers in 1872. To the proceedings of this society he contributed but one paper, but this, which dealt with automatic expansion gear and was published in 1882, has been a mine from which hosts of engineers interested in governors have delved theorems and data of the utmost practical value. Of late years far too many papers read before our technical societies have been reduced to all but insignificant importance by the deliberate omission of the most pertinent facts and figures. Mr. Hartnell's paper was marred by no such suppressions and, in particular, mention may be made of the results of his experiments and experience with springs, which were duly recorded, and showed that in practice working stresses twice as high as those suggested by Rankine could be adopted without danger. This discovery constituted a most valuable contribution to our engineering data and found applications in every branch of engineering practice. In spite of his age, Mr. Wilson continued to take an active part in the affairs of his firm, Messrs. Wilson Hartnell and Co., of Leeds. He leaves behind him a widow and two daughters, an only son, Lieutenant-Colonel Cuthbert Hartnell, having been killed in action in France.

INDUSTRIAL NOTES.

Field Marshal Earl Haig addresses an appeal to trade unionists in *The Democrat* in favour of the men, to the number of over 250,000, who fought for the people of this country in the great war, able-bodied as well as disabled, who are still seeking for a means of earning bread for themselves and their families. It is required to place in trades which will give them a lifelong occupation these men who gave up the most valuable years of their lives to the service of their country. Normally, they would have passed through their apprenticeship during the years they were in France; they could now have been skilled members of their calling and entitled to all the benefits and protection their trade union could give them. Now, however, many are shut out even from the chance of leaving a trade by reason of the rules which govern the unions and which some unions will not relax. "But," asks the Field Marshal, "is the fear lest the entry of the ex-service men into the ranks of organised labour, through a relaxation of the rules, should lead to a glut in the labour market and consequent under-employment well-founded? The country and the whole world are crying out for commodities to replace the waste of war and to catch up with the arrears caused by the absence of so large a number of men from industry while war raged . . . The ex-service man has no time to lose. The years of his life are slipping from him when he should be at his best as citizen, parent and workman . . . It is the A 1 class of the population—or a part of it—to which the right to work and reproduce itself is being denied . . . It is essentially a question for trade unions to make their own. If they fail to deal with the problem there may grow up outside the movement groups of men who will go into the labour market without that protection which a trade union gives and thus become a menace both to wages and conditions. I suggest that the unions would best consult their own interests if they withdrew the barriers which now prevent these men from becoming full members of organised trades, and thought out a scheme for absorbing them with the least possible dislocation of employment . . . The trade unions are, in this case, mighty to save. I want their help in the heavy task I have undertaken on behalf of my old comrades."

A Bill has been presented to Parliament to make better provision for the employment of unemployed persons by facilitating the acquisition of, and entry on land required for works of public utility and for purposes connected therewith. The term "works of public utility" means the construction and improvement of roads or other means of transit, the widening or other improvement of waterways, the construction of sewers or water works, the reclamation or drainage of land, and any work connected with any of the aforesaid works.

A singularly absurd proposal is made by Mr. John Hill, the general secretary of the United Society of Boilermakers and Iron Shipbuilders, in the Society's report for the present month. He suggests that a minimum return of 5 per cent. on the capital invested in all industrial undertakings should be guaranteed by the Government, and that all surplus over and above this should be divided between the investor and the workman by increasing wages and dividends in equal percentages. Broadly speaking, the proposal constitutes a plan for endowing incompetent management, whilst the investor who takes gambling risks and, like Lord Masham, spends about a quarter of a million in the attempt to develop a new industry, is to receive, in case of success, no return commensurate with the extraordinary courage and enterprise displayed. Some nine-tenths of the earnings due to the investor's genius are, Mr. Hill suggests, to be handed to the said investor's workmen, who will not have worked any harder than workmen employed by other less able and courageous masters. Under such conditions it would be impossible to build up large works from small ones, or to install improved machinery on the usual scale. As matters stand, by far the principal gainer by successful enterprise is not the much-abused employer, but the consumer. For example, Sir Henry Bessemer made, if our memory serves us right, a fortune of about 800,000*l.*, but the annual value to the world of his discoveries and inventions has been estimated in hundred millions sterling.

The only outstanding paragraph in the monthly trade report of the United Patternmakers' Association for the past month is contained in a letter from a member who resides in Newcastle-on-Tyne. He says: ". . . In closing, I would like to associate myself in the protest of the Portsmouth branch against our general secretary using our monthly report for his political propaganda. I suggest that if he cannot find anything else to give us he should devote the whole of his time to *The Daily Herald*, or take the place of Sylvia Pankhurst on *The Workers' Dreadnought*."

The executive of the Miners' Federation met in London last Friday the Central Committee of the Mining Association, to discuss unemployment insurance and matters arising from the recent strike settlement. Mr. Evan Williams presided and Mr. R. Smillie occupied the vice-chair. Both owners and men agreed that it was advisable for the industry itself to undertake the responsibility for dealing with its own unemployment, instead of coming within a National Insurance Scheme. It was stated that whereas for the workers as a whole the proportion of unemployed was 6·5 per cent., in the case of the coal miners it was less than 1 per cent. In regard to coal output, both sides gave evidence of their desire to co-operate to increase this. Sub-committees were appointed to consider the various questions to be dealt with. The date for a later conference has not yet been fixed.

Mr. Finlay Gibson, secretary of the Monmouthshire and South Wales Coalowners' Association, has stated that recently the South Wales Supplies Committee had an interview with Mr. Bridgeman, Minister of Mines, in order to place before him the effect which the scheme of limitation of exports had upon output. It was then shown that coal output had decreased, and working time had been lost at the collieries since the introduction of the scheme. The committee therefore urged the Government to arrange that the quantity to be supplied for home consumption be definitely fixed, leaving the balance free for export. Mr. Gibson said that in consequence of the special conditions prevailing in the South Wales coalfield, the output could not, in his opinion, be increased to any appreciable extent until the scheme of limitation was amended.

The report of the National Joint Industrial Council for the tramway industry was issued last Saturday in connection with an application for increase in wages dated October 15, 1920, of 12*s.* per week for adults, and 6*s.* per week for youths under 18 years of age. The application for increased wages, the report says, would involve a further wages charge of, approximately, 1,481,100*l.*, which represents an additional 1·59*d.* per car-mile. At the present time, the annual loss amounts to approximately 3,310,753*l.*, assuming that the same mileage is run in 1920–21 as in 1919–20. With the additional charge for wages now demanded, the annual loss would be approximately 4,793,597*l.* According to the report the tramways industry is now confronted with a most serious problem, which must be tackled forthwith, if it is to be saved from financial disaster. The council have laid down the financial proposition, with which the Ministry of Transport do not disagree, that this industry should be self-supporting, that it should not be subsidised by compulsory local taxation, and therefore that the rider should pay the cost of the ride in the fare charged. Taking the industry as a whole, the actual revenue at present falls short of the approximate expenditure by 3·5*d.* for every car-mile run. In other words, the deficiency amounts to 3*s.* 2½*d.* for every pound sterling of traffic receipts, but if the amount of the increase in wages now asked for was added to the present approximate expenditure, the corresponding figures would be 5·14*d.* per car-mile, and 4*s.* 8*d.* for every pound sterling of traffic receipts.

The executive of the South Wales Miners' Federation have appointed Messrs. T. Richards and Noah Arlett to succeed Messrs. Brace and Hartshorn as representatives on the National Council. They have also appointed Mr. James Winstone to act as president and Mr. Enoch Morel as vice-president of the South Wales Federation until the ordinary elections next July.

Sir Robert Horne stated in Parliament last Monday that the total values of the imports into, and of the exports and re-exports from the United Kingdom during the nine months ended September 30, 1919, and 1920, respectively, were: Imports for 1919, 1,168,000,000*l.*; imports for 1920, 1,501,000,000*l.*; Exports for 1919, 541,000,000*l.*; exports for 1920, 1,007,000,000*l.* Re-exports for 1919, 98,000,000*l.*; re-exports for 1920, 180,000,000*l.*

"If the recent unhappy struggle in the coal-mining industry conveys no warning lesson to the workers, it is vanity to hope for their political or industrial salvation," says Mr. F. H. Rose (Labour Member for Aberdeen), in *The Liverpool Courier*. Mr. Rose reviews the loss caused by the recent coal strike, states its effects on the country and concludes by saying that "if arbitration be good—as all orthodox labour men say it is—for the prevention of international war, can it be evil as applied to industrial conflicts? One need not be a slave to the idea of perfect consistency to be able to admit that a little of it applied to industrial life might not prove altogether disastrous. At least, it is time that organised labour gave the proposition serious and respectful thought."

A national strike of technical, supervisory and executive engineers at electricity undertakings of the United Kingdom who are members of the Electrical Power Engineers' Association, is threatened on December 14 unless there is a settlement of the dispute which has arisen over the wages schedule. The association has issued an ultimatum to the employers, but at the request of the employers' side of the National Joint Board for the electricity supply industry, the strike notices, which were originally intended to expire in a fortnight, have been extended to December 14, to enable the employers' side of the Board to persuade the undertakings concerned to observe the schedule. The schedule of salaries is based on the size of the plant which the engineers and their assistants control. The whole of the municipal and private electricity undertakings of 1,000 kw. and over in England, Scotland and Wales are involved, the total number, including London, being 240. The members of the Electrical Power Engineers' Association do not run the plant, but comprise the skilled supervisors and technical staffs, chief engineers and their assistants and station superintendents. If the threat is carried into effect it would be impossible with safety to keep the machinery going and maintain the electricity supply.

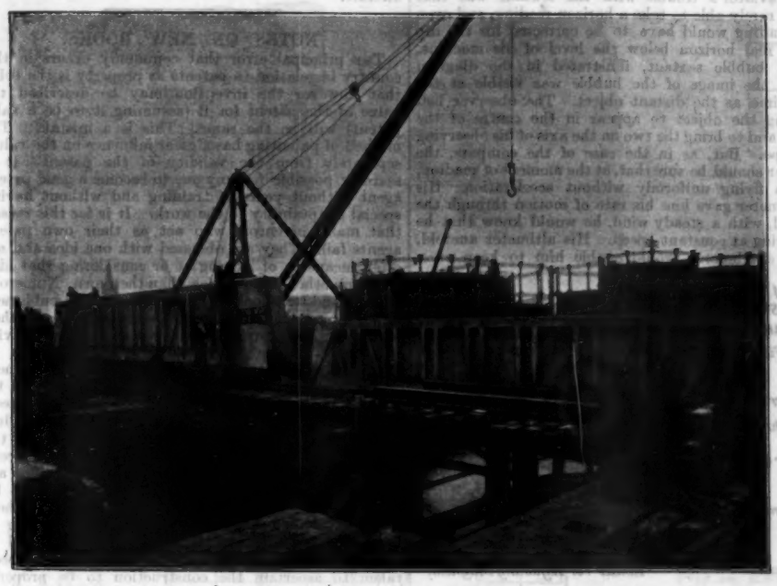
Mr. W. A. Jones, secretary of the association, stated that the trouble arose over the recommendations of the Joint Board of Employers and Employed, in respect of a schedule of wages, which should have come into operation nearly six months ago. The Board was formed on Whitley Council lines, to settle basic rates of pay, and the schedule was agreed upon by the Board. The majority of the employers had, however, failed to adopt the schedule. The smaller undertakings were not at present involved. The employers' side of the National Joint Board has circularised the undertakings urging them to accept the schedule which had been agreed to by representatives of every section of the industry. The circular stated that a grave crisis had arisen, and that every effort should be made to avert a stoppage.

The strike notices are to take effect unless the schedule of salaries has been adopted in its entirety by December 11.

The Institution of Mining and Metallurgy.—The following awards have been made by the Council of the Institution of Mining and Metallurgy: (1) The gold medal of the Institution of Mining and Metallurgy, the highest distinction in the power of the Council to bestow, has been awarded to Sir Thomas Kirke Rose, D.Sc., Assoc.R.S.M., M.Inst.M.M., "in recognition of his eminent services in the advancement of metallurgical science, with special reference to the metallurgy of gold." (2) "The Consolidated Gold Fields of South Africa, Limited," gold medal and premium of 40 guineas have been awarded to Mr. H. Livingstone Sulman for his paper "A Contribution to the Study of Flotation" (Transactions, Vol. xxix, 1919–20).

REINFORCED CONCRETE BRIDGE; REGENT'S CANAL.

CONSTRUCTED BY MESSRS. SIR ROBERT McALPINE AND SONS, ENGINEERS, LONDON.



A PIECE of work which is of some interest, owing to the conditions under which it has been done, is the construction of a new reinforced concrete bridge over the Regent's Canal, near York Road, King's Cross. This bridge forms part of a scheme to provide a new entrance from Wharf Road to the Great Northern Railway Company's goods yard, which includes the provision of new approaches, and the demolition of the old steel bridge over the canal. The work is being done by Messrs. Sir Robert McAlpine and Sons, Westminster, S.W. 1.

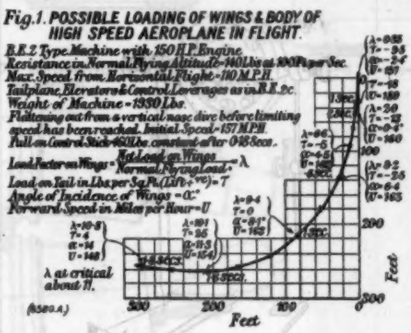
Owing to the necessity of not obstructing the canal, it was found impossible to construct this bridge in place, as the necessary shuttering and supporting timbering would have reduced the headway and waterway width below the permissible limit. It was, therefore, decided to construct the three girders of the bridge independently and afterwards place them in position. The girders were accordingly built on shore, in line with their proper positions, and when finished each was lifted on to two four-wheeled trucks. When they were ready for launching, one bent of piles was driven in the fairway and a track laid on temporary girders thrown across the canal. The girders were then launched in succession, and on being carried over were jacked and lowered into position after the removal of the temporary gear. The operation was quickly accomplished and the headway was not obstructed at all, while the one pile-bent reduced the obstruction of the waterway to a minimum, both in the matter of actual width and length of time.

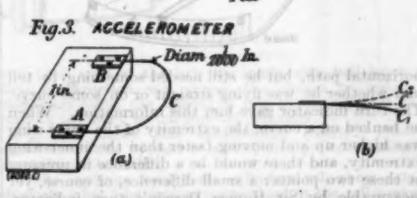
The accompanying view shows the east girder already in position, and the centre girder on its carriage ready for launching, and gives a good idea of the whole operation. The centre girder weighed 50 tons. The span is 45 ft. Once the three girders were placed, work was commenced on the flooring in place. For this, shuttering hung from the top side of the girders was employed so that nothing interfered with the full head room for canal traffic. The work, as already stated, has been carried out by Messrs. Sir Robert McAlpine and Sons for the Great Northern Railway, under the supervision of the latter company's engineer, Mr. C. J. Brown, C.B.E., M.Inst.C.E.

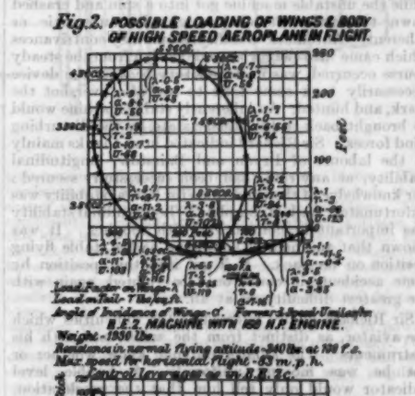
BLAST FURNACES IN HOLLAND. — Messrs. Freyn Brassert and Co., engineers, Chicago, have been appointed consulting engineers for the Royal Nederlands Blast Furnace and Steel Works Company, The Hague, according to *The Iron Age*, New York, and plans and purchases are under way for the construction of two blast-furnaces at Ijmuiden, Holland. The plant is planned on American lines throughout, inclusive of furnaces, hot blast stoves, gas washing, ferro-concrete bins, charging, blowing and other equipment. The decision of the Royal Nederlands Blast Furnace and Steel Works Company followed a careful investigation of plants and practice both here and abroad by the officials of the company. The plant will be the first application of American furnace practice, filling, blowing and general operation with Continental ores and cokes.

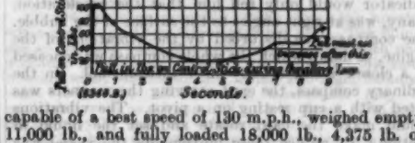
SOME REQUIREMENTS OF MODERN AIRCRAFT.

THE differences between the requirements of military and of commercial flying are not merely due to the fact that the military flying machine has developed into a formidable weapon, whilst commercial aircraft must be a means of rapid transit and transport. Discoursing upon "Some Requirements of Modern Aircraft," before the British Association, at the August meeting in Cardiff, Sir R. T. Glazebrook, F.R.S., Griffiths, late Principal of the University of South Wales, who proposed the vote of thanks, as well as by the members.









The lift, the upward force on an aeroplane, Sir Richard explained, was greatest for an approximately rectangular wing when the long side was horizontal and at right angles to the direction of flight, so that lift $W = k_1 \rho s v^2$, where ρ was the air density, s the area and v the speed of the machine, and k_1 the lift coefficient, depending both upon the section of the wing and on the angle between the bottom chord of the wing and the flight direction, i.e., the angle of attack. As the angle of attack increased, and the wing was held more and more obliquely, the lift coefficient increased until the angle was about 15 deg.; at this stalling angle k_1 suddenly dropped, and the wing ceased to support the weight it had borne. The actual values reached by k before stalling differed appreciably; 0·6 or 0·7 was about the usual maximum, but 0·9 had been exceeded by Messrs. Handley Page and by the Blackburn Company.

The stalling speed, the minimum speed at which the machine could fly, was inversely proportional to the square root of the maximum lift coefficient, and since $W = k_1 \rho s v^2$, $W/s = k_1 \rho v^2$, this quotient expressing the "loading," i.e., the weight carried per unit wing area; the loading varied between 5 lb. and 10 lb. per sq. ft. The drag or resistance to the motion of the wing, was equal to $k_2 \rho s v^2$, the drag coefficient k_2 also depending upon the shape of the wing section and the angle of attack. As that angle increased, k_2 decreased at first, then increased more and more as the angle grew steeper. But k_2 was always smaller than k_1, and the force D required to move the wing was given by $D = W k_2/k_1$. The resistance of the rest of the machine was about the same in amount as that of the wing. The resistance was entirely due to the friction between the moving body and the air, and to the viscosity of the air, and the friction itself due rather to the eddies than to the direct motion of the machine through the air. Sir Richard elucidated all these points by numerous diagrams.

As regards the engines, the weight per horse-power was smaller for radial air-cooled engines than for water-cooled motors; 3 lb. per horse-power was perhaps a reasonable figure. According to Bairstow, a light aeroplane capable of travelling at 125 miles p.h. would be able to carry a useful load of 270 lb. out of a total weight (machine, engine and pilot) of 2,100 lb. The modern Bristol Pullman triplane for 14 passengers, capable of a best speed of 130 m.p.h., weighed empty 11,000 lb., and fully loaded 18,000 lb., 4,375 lb. of that total being available for cargo or passengers. The engines, Sir Richard remarked, were certainly not yet reliable in the sense that marine engines were reliable. The useful load could be increased by making the structure light. A light machine could be flown at a lower angle of attack, but the structure must remain sufficiently strong, and the calculation of the stresses was not an easy matter, except when the machine was moving horizontally. In steep diving, at twice normal speed, the stresses might rise to 16 times their magnitude for normal flight, if the pilot were able to change his controls instantaneously and although that was impossible, the controls could be changed within one-fifth of a second. For these calculations the "load factor" was important, this factor indicating the ratio of the stress in any part of the structure under given conditions of flight to the stress under normal conditions of horizontal flight. The load factor during recovery from a dive could be determined in two ways. Starting with an aeroplane diving at

quoted from a remarkable paper recently communicated by Squadron Leader R. M. Hill, to characterise these differences: "If commercial aeroplanes are to compete successfully with other forms of transport, they must compete on grounds of economy, speed and reliability, but such achievement will not be of the slightest value until a standard of safety nearer to that reached by railways and shipping is attained. The most pressing difficulties seem to be those of flying to a place and landing when there is a mist down to the ground, of the comparative unreliability of the light aero-engine, of the space which any aeroplane requires to land in, and of the imperfect control of small aeroplanes at low speeds and of large ones at any speeds." To many of these difficulties Sir Richard could only allude in his discourse, but the problems are all intimately interconnected, and their clear characterisation by Professor Glazebrook was greatly appreciated by Dr. Stratton, Director of the United States Bureau of Standards, and by Professor E. H.

a given speed we could calculate the initial stresses on the parts, and if we knew the aerodynamic forces, the values of k and the resistances of the various parts, and if we were able to make some assumption as to the rapidity at which the pilot altered his controls, we could determine mathematically the rest of the path and the stress on the machine at any point of that path. Fig. 1 shows the results of that calculation for a machine flattening out from a dive, and Fig. 2 the results from a machine doing a loop. In both cases the machines were moving at high speeds, and high load factors were required for safety. In the former case the pull on the control levers was 160 lb., reached after 0·18 second; in the latter case it was 100 lb., attained in about the same period.

The other method of determination relied upon the experimental measurement of the forces on the machine as a whole by the aid of accelerometers. On aeroplanes pendulums of heavy weights or springs of high inertia, which would go on swinging, would be useless. The accelerometer used took the form illustrated in Fig. 3. It consisted of a quartz fibre, 1/2,000th in. in diameter, bent to an arc A B C, and held, normally, in a horizontal position. The fibre would be slightly deflected downwards by its weight, and would be still more deflected by a vertical acceleration, and this additional deflection of the point C to positions C_1 or C_2 was recorded photographically. The accelerometer camera and the lamp were contained in a small box strapped to the observer's knee. The curves thus obtained indicated only the accelerations of the centre of gravity, Sir Richard added, without taking account of the twists and turns about this centre. The kinematograph had also been utilised at the Royal Aircraft Establishment for the determination of the stresses. A kinematograph was fitted on to the tail of one machine rising steadily, while the second machine following close behind performed the loop spin, or other evolution, it was desired to analyse. Series of these very interesting photographs were exhibited.

Passing to stability, Sir Richard emphasised that a commercial machine should be stable, as it would, be impossible, without a great expenditure of the pilot's energy, to fly through a continuous cloud. Yet stability pushed too far gave the machine a will of its own and made it sluggish, and military pilots, to whom rapid control meant life or death, differed as to the desirability of stability. On the other hand, the stable machine would fly on, if the pilot lost control, and, if the engine stopped, the machine glided down, while the unstable machine got into a spin and crashed down to earth. Stability might be automatic or inherent. Automatic stability, secured by contrivances which came into play when a deviation from the steady course occurred, was unsatisfactory because the device necessarily took some time to operate, overshot the mark, and hunted. An inherently stable machine would be brought back to the steady state by the disturbing wind forces. Sir Richard indicated how, thanks mainly to the labours of Bryan and Bairstow, longitudinal stability, at any rate, had been successfully secured; our knowledge of the conditions for lateral stability was unfortunately far less complete. Longitudinal stability was important in connection with looping. It was known that an unstable aeroplane had a stable flying position on its back. If it got into that position by some accident, it could only be righted again with the greatest difficulty, if at all.

Sir Richard finally referred to the difficulties which the aviator, as distinct from the sailor, had with his instruments. The aviator did not know whether or not he was moving uniformly. A bubble level indicator would only tell him that the acceleration, if any, was at right angles to the surface of the bubble. The compass was disturbed by the vibrations of the engine, to damp which the whole compass was encased in a closed vessel usually filled with alcohol. In the ordinary compass, the card carrying the magnets was fitted with a cup resting on a pivot. The vibrations would make the card rotate and set the liquid in motion; to reduce these movements the vessel was made spherical, the pivot and cup were interchanged, the cup being attached to the support, and the card itself was replaced by a short length of a cylinder having the cup on its axis. Even thus improved the R.A.F. spherical compass, of which Fig. 4 gives a diagrammatic section, would, on an initially northern course, move to the east or west, only, say, 10 deg., when a turn of 15 deg. had been made, because, in describing the curve, the aeroplane was banked inwards so that the axis of the magnet card did not remain vertical, and the directive force on the magnet was no longer the full horizontal component of the earth's field. Moreover the compass could not take up its position instantaneously. When the compass turned more quickly than the aeroplane, the observer would at first imagine that he was steering towards the west when he was really turning eastward. This trouble could be remedied by making the time of swing of the needles long compared with the time taken by the machine to complete its turn. On a northerly course the turn would then appear in the right direction, though too small in amount; on a southerly course the turn would also appear in the right direction, but too large in amount.

The aviator's trouble with the sextant was that he was rarely able to take a horizon reading, and even that reading would have to be corrected for the dip of the real horizon below the level of his machine. In the bubble sextant, illustrated in the diagram Fig. 5, the image of the bubble was visible at the same time as the distant object. The observer had to bring the object to appear in the centre of the bubble and to bring the two on the axis of his observing telescope. But, as in the case of the compass, the observer should be sure that, at the moment of reading, he was flying uniformly without acceleration. His speedometer gave him his rate of motion through the air, and, with a steady wind, he would know that he was flying at constant speed. His altimeter aneroid, or his climbmeter, would enable him to keep on a

Fig. 4. R.A.F. SPHERICAL COMPASS. DASHBOARD MOUNTING. DIAGRAMMATIC SEC.

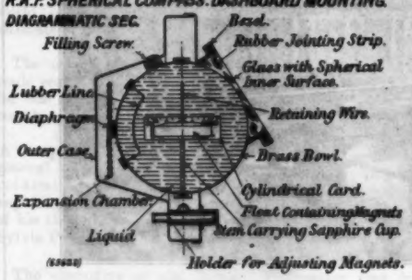


Fig. 5. R.A.E. SEXTANT MARK II A.

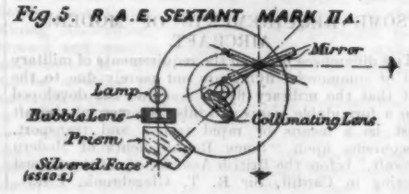
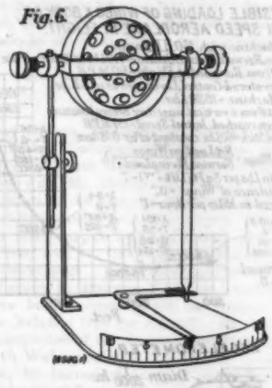


Fig. 6.



horizontal path, but he still needed something to tell him whether he was flying straight or on some curve. The turn indicator gave him this information. When he banked on a curve, the extremity of the outer wing was higher up and moving faster than the inner-wing extremity, and there would be a difference in pressure at these two points; a small difference, of course, yet measurable by Sir Horace Darwin's turn indicator, which marked zero when the aeroplane was travelling straight. In the gyro-turn indicator, developed at Farnborough, the principle of which is explained by the diagram Fig. 6, the gyro-wheel was placed outside the machine so as to rotate in a vertical plane at right angles to the direction of flight, the rotation being maintained by the wind playing upon suitable holes in the wheel. If the machine moved straight horizontally and began to turn about a vertical axis, the pointer would indicate that motion or, if controlled by a spring, would show the force tending to make the axis move.

There remained the dangers from mists and fogs, which were more formidable to the aviator than to the sailor. The sailor had fog signals, leader cables, buoys and harbour lights to guide him; the aviator frequently had little warning that he was within a few feet of the ground. Captive balloons, if feasible, were themselves sources of danger; sound signals would not be appreciated by the neighbours of aerodromes; signal beams did not penetrate far through mists; radio telegraphy and radio telephony promised best. But the landing troubles and means of control at low speeds, as well as the construction of reliable aero-engines, remained urgent problems of modern aircraft.

NOTES ON NEW BOOKS.

The principal error that commonly occurs in this country in relation to patents as property is the belief that however the invention may be described the value of the patent for it (assuming it to be a valid patent) will be the same. This is a mistake. The method of patenting has a great influence on the value, separately from the validity of the patent. It is scarcely possible for any one to become a good patent agent without years of training and without having special adaptability to the work. It is for this reason that many inventors who act as their own patent agents fail. They are obsessed with one idea and are often incapable of looking at or considering that idea from any other point of view than their own. Numerous primers and text books on patents have been published, but they are not intended to supersede, nor can they supersede the professional guidance and advice in specific cases and circumstances, which is so necessary where any material interest is concerned. Primers and text books, such as we have referred to, act as useful guides and finger posts to patentees, manufacturers and investors in patents. Patent law has been slow of growth, and notwithstanding the many amendments that have been made to it in recent years, it is not yet ideal. Many of its provisions are obscure in meaning and can only be understood by reference to the history of the subject. Others apparently clear enough have a different meaning in law from that which would be popularly assigned to them and hence lead to error, unless care has been taken to ascertain the construction to be properly placed on them. One of the recent primers or guide books is "*A Handbook on Patent Laws of all Countries*," by W. P. Thompson (Stevens and Sons, London, 6s. net). This does not attempt to enable every man to be his own patent agent, but its aim is to answer generically, so far as it can, the many questions that may crop up in patent law day by day. In our experience, no book on patent law is ideal, and it is only experience and everyday contact with the subject that enables one to give advice. It is within the experience of all that everyday contact with a subject causes a person to act in a manner which to others who are not so familiar with the subject may appear strange. This is so with patent law and practice. The handbook we have referred to contains a brief *resumé* of the patent, design and trade mark law in this country and also deals alphabetically with the patent laws of the various countries in the world in which that kind of protection is available. It gives the principal points of interest to patentees and manufacturers, but does not in any way pretend to be more than a guide.

The firm of Charles Griffin and Co., Limited, familiar to all engineers as the publishers of Rankine's pioneering treatises, celebrated its centenary this year, and in commemoration thereof have issued a handsome volume giving some account of the history of the firm, together with a series of appreciations by a number of leading authorities. The foreword is contributed by Lord Moulton. The founder of the firm was Joseph Griffin, who as far back as 1795 was conducting a successful business in Nile-street, Glasgow, in the sale of books and philosophical instruments, but the firm produced its first publication in 1820. It early began to specialise in scientific and technical treatises, and throughout has aimed at and maintained a very high standard in regard to these.

Construction of Second Simplon Tunnel.—The Commercial Secretary to His Majesty's Legation at Berne reports to the Department of Overseas Trade that down to the end of September 18·250 km. (92 per cent.) of the second Simplon Tunnel had been pierced out of a total length of 19·825 km. On the same date 90·9 per cent. of the total length of the tunnel had been walled and wholly completed.

German Commercial Activity.—The *London and China Telegraph* states that according to the *North China Daily News*, the German engineer, Kocher, who was recently nominated Director-General for the whole of China on behalf of the German electrical firm of Siemens, has contracted to supply the machinery necessary for the exploitation of a colliery near Hang Chow, in spite of the fact that Germany maintains her inability to manufacture such machinery for the restoration of the French coalfields. Moreover, Kocher has ordered from Germany a quantity of electrical tramway-factory equipment and other plant, severely undercutting English, French and American products. Kocher was one of the most active German propagandists in China during the war. Owing to Chinese influence he was not repatriated.

EXPERIMENTAL ROLLING MILLS.

HYDRAULIC SUPPORT CYLINDERS APPLIED TO THREE-HIGH BAR MILL.

SECTION ON LINE HH.

Fig. 20.

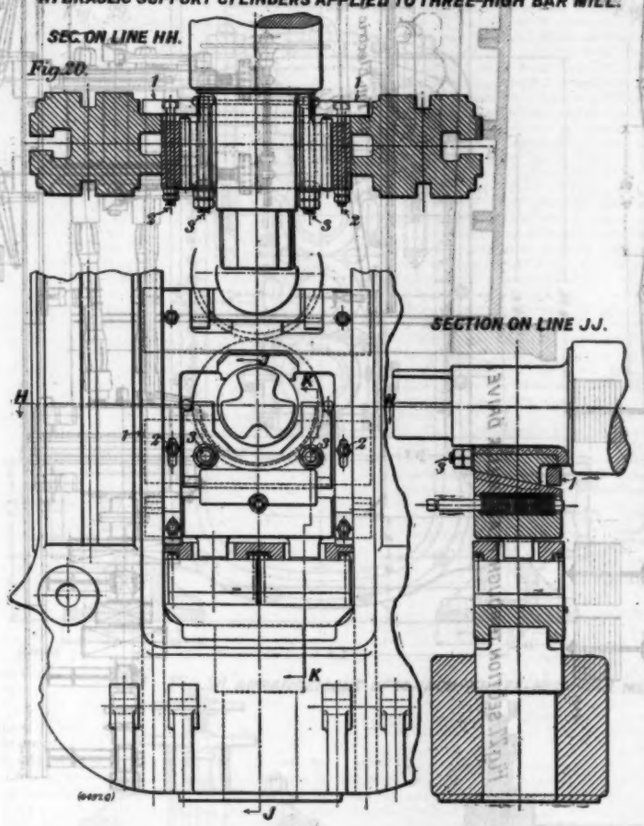


Fig. 21. SECTION ON LINE K.K. of Fig. 20.

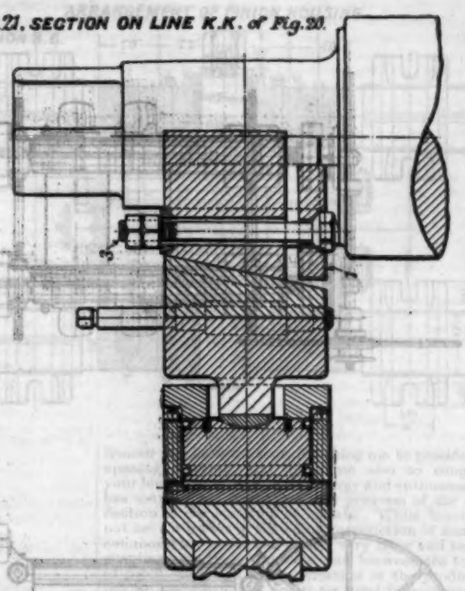


Fig. 22. EXAGGERATED ILLUSTRATION SHOWING APPLICATION OF LOAD TO NECK BEARING.

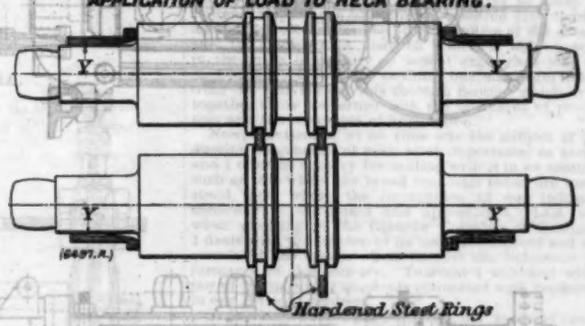
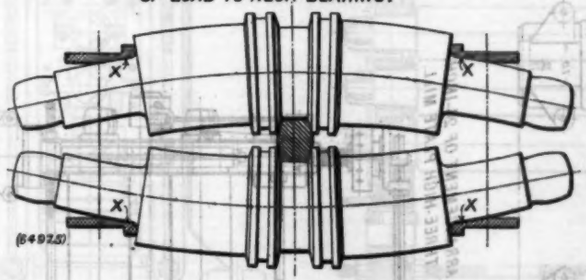


Fig. 23. EXAGGERATED ILLUSTRATION SHOWING APPLICATION OF LOAD TO NECK BEARING.



THE BUREAU OF ROLLING-MILL RESEARCH.*

By W. B. Skinkle.†

(*Concluded from page* 655.)

In the German Government laboratory for testing materials, Dr. A. Martens did a great deal of work with cylinders of this type for recording both large and small loads, and strongly recommends it as the most sensitive type of recording mechanism for loads of almost any magnitude or any suddenness of application. The credit for the arrangement of two of these cylinders in such a manner as to form a Prony brake and record the friction losses on roll necks should go to Professor W. Trinks.

Fig. 20 shows these cylinders and the details of their application to a three-high bar mill. Note that the lower roll has a wedge adjustment which permits a slight movement of the roll up or down without in any way interfering with the action of the support cylinders.

Another point to be considered in this connection is the fact that the chock or thrust plates 1, on the inside of the housing would offer a serious resistance to the turning tendency of the lower roll bearing if the thrust bolts 3, which draw the neck brasses against the shoulder of the rolls, were of the usual construction. To avoid this difficulty, the holes of these bolts are drilled large, and both ends of the bolt are made with ball joints. This construction will permit the chocks to remain stationary while the bearing is free to transmit all its turning tendency to the support cylinders.

Fig. 21 shows this construction clearly. These cylinders will be applied to all roll and pinion housings throughout the mill.

While readings from these cylinders will show conclusively what friction loss is sustained at the roll necks and what load is carried by both roll and housing, they will not record the losses in the transmission machinery between motor and roll. The measurement of these losses presents a second important problem. Figs. 22 and 23 show an exaggerated illustration of conditions at the roll-neck bearing and a method of locating the transmission losses when the rolls are under load.

When a bloom is being rolled, the heavy pressure between steel and roll causes the roll to deflect, placing the maximum pressure on the inside of the bearing, as illustrated at X of Fig. 23, while the pressure is moved out as shown at Y of Fig. 22, when the roll is running light or is not deflected due to the bloom. It would, therefore, be useless to return the same load on the roll necks by means of the screws or hydraulic cylinders, unless a means is found to deflect the roll to the same elastic curve which it had when the bloom was being rolled, and by this means to restore the same conditions of roll-neck bearing and lubrication.

This can be done by inserting two hardened steel rings, in grooves at each side of the pass as shown in Fig. 22 and then raising the pressure in the hydraulic support cylinders until they record the same pressures that existed during the rolling of the bloom. The hardened steel rings will not elongate or change their shape, therefore no work will be done on them. The coefficient of rolling friction on machined surfaces of this kind is very low—low enough to be well within the allowable percentages of error. We will, therefore, have restored the loads on the transmission machinery, except for the net work required to roll the metal. The readings of the wattmeter will show the overall friction losses in the system, and after motor losses have been deducted the remainder will be the total loss in power due to friction losses in the transmission machinery. The difference between the total load when rolling and the readings just described will be the net work required to roll the metal.

Fig. 24 shows an assembly of the closed-top housing when used as an 18-in., three-high bar mill. The fillings are so designed that 16-in. rolls may be used with only a change in the neck brasses. Fig. 25 shows this same housing when assembled as a 24-in., two-high, balanced sheet mill. The roll-balancing mechanism may be omitted if work as a jump mill is to be done. The same fillings may be used for cold-mill work.

Fig. 26 shows the large housing assembled as a 24-in., three-high plate mill with 16-in. middle roll. The bearings at the top of the housing carry the cross-shafts of the synchronising mechanism for the middle roll. Cylinders to raise and lower this middle roll are bolted to the shoe plate beside the housing. Fig. 27 shows a cross-section through the laboratory, with this mill connected with the drive.

The middle roll and its operating mechanism may be left off and the mill assembled with either 24-in. plate or blooming-mill rolls if it is desired to operate either of these types of two-high reversing mill.

Fig. 28 shows the assembly of the smaller open-top housing when used as a 14-in., three-high bar mill. These same fillings may be used for either 12-in. or 16-in. rolls. A second set of fillings will be necessary for 10-in. rolls. It will thus be seen that we can assemble any size rolls between 10 in. and 24 in. diameter, with necks between 6 in. and 18 in. diameter, in at least one of these housings.

Fig. 29 shows the assembly of the pinion housing, which is made sufficiently large to assemble a combination of 24-in. top and bottom with 16-in. middle pinion, or 18-in., three-high pinions, if desired. The housings

* Paper read before the Engineers' Society of Western Pennsylvania.

† Director, Bureau of Rolling-Mill Research, Carnegie Institute of Technology, Pittsburgh.

EXPERIMENTAL ROLLING MILLS.

Fig. 24. ARRANGEMENT OF 18-INCH, THREE-HIGH BAR MILL.

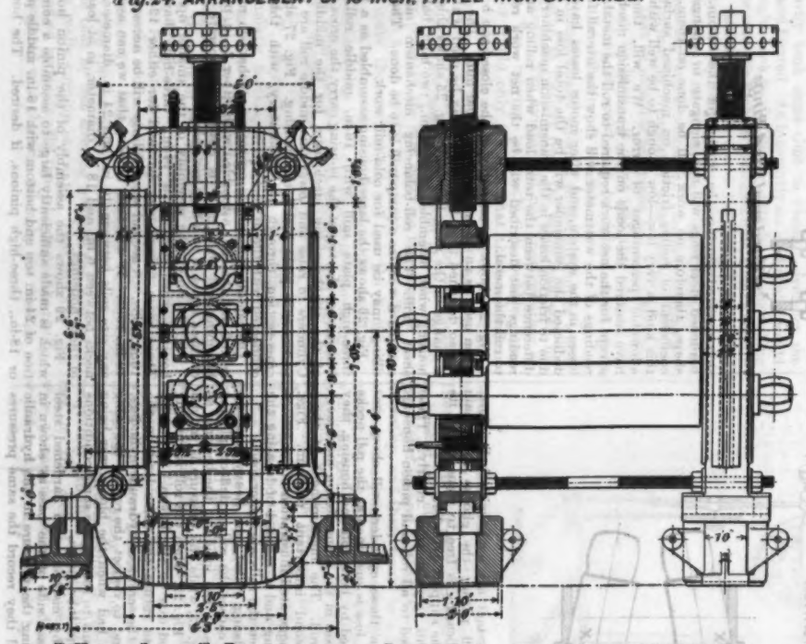
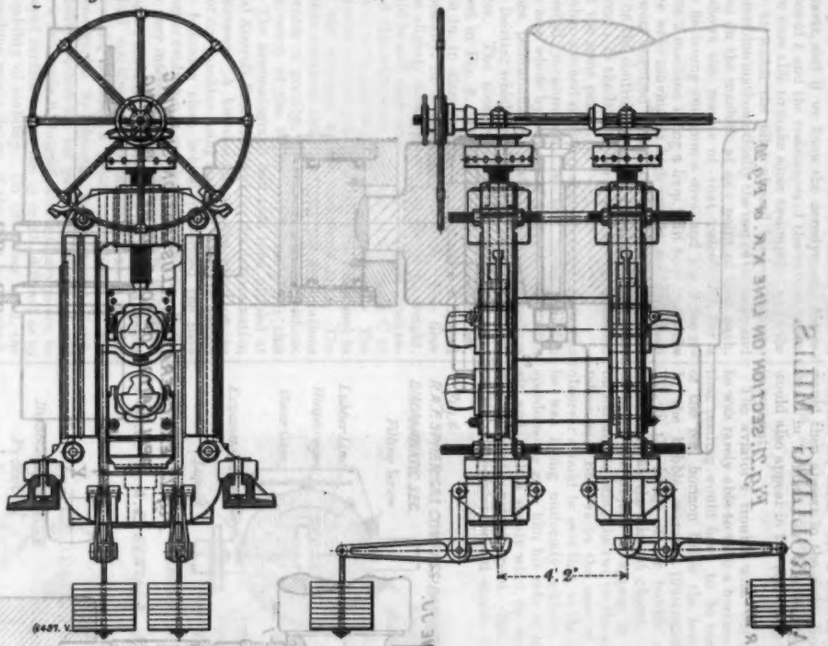


Fig. 25. ARRANGEMENT OF 24-INCH, TWO-HIGH BALANCED SHEET MILL.



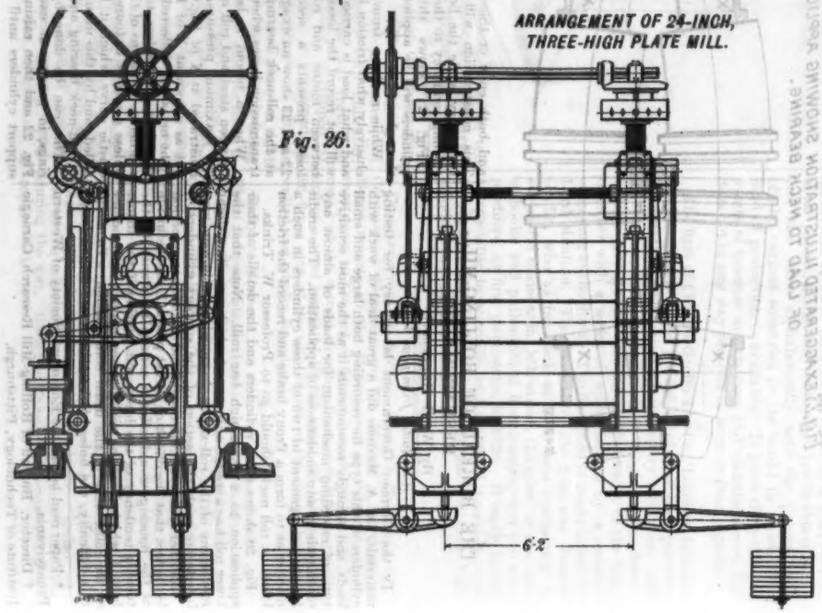
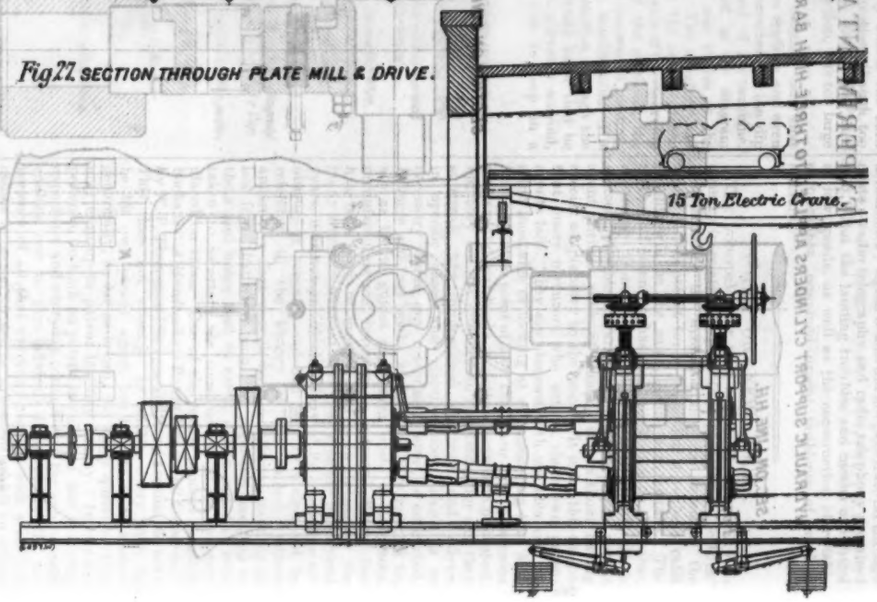


Fig. 26. ARRANGEMENT OF 24-INCH, THREE-HIGH PLATE MILL.

Fig. 27. SECTION THROUGH PLATE MILL & DRIVE.



EXPERIMENTAL ROLLING MILLS.

Fig. 29.

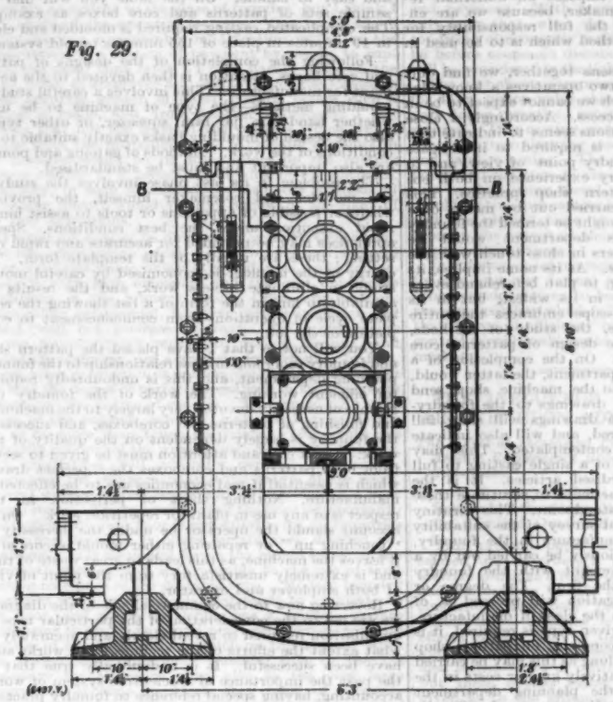
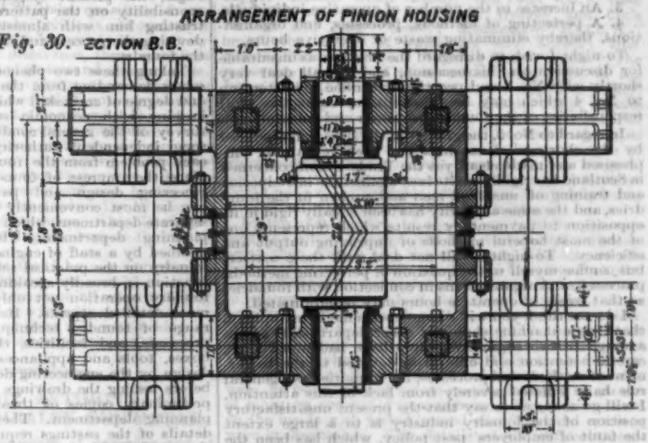
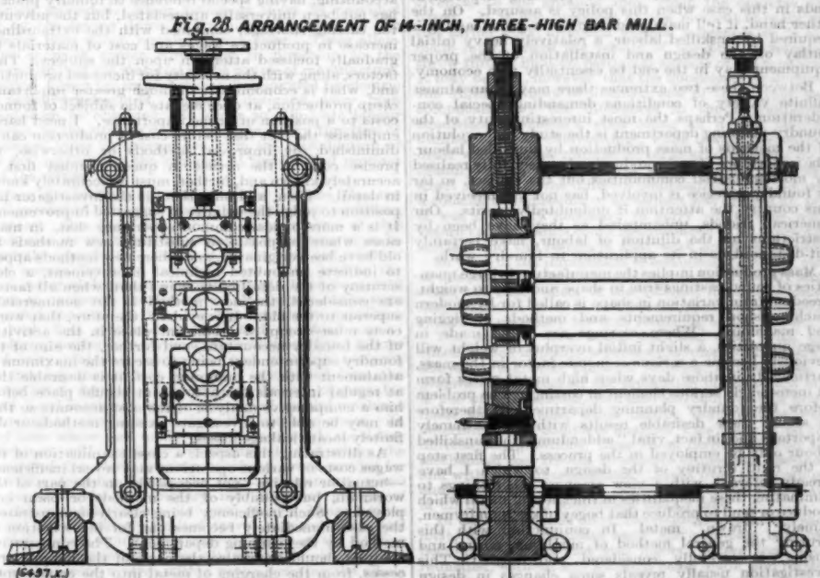


Fig. 30. SECTION B.B.



ARRANGEMENT OF PINION HOUSING

Fig. 28. ARRANGEMENT OF 14-INCH, THREE-HIGH BAR MILL.



also have a wide filler which may be changed to accommodate various widths of pinion face.

The heating furnaces will be just as carefully designed as the mill. At present we contemplate installing two furnaces approximately 3 ft. to 12 ft. inside, which will be either oil or gas fired. They will be fully equipped with a system of recording pyrometers, gas meters and flue-gas analysing apparatus, &c. Everything within reason will be done to equip these furnaces for careful work on fuel economy.

This concludes the mechanical features of the mill as far as they have progressed. Before bringing the paper to a close I would like to touch on the education and organisation sides of the Bureau.

During the war, the Carnegie Institute of Technology had several thousand men stationed at the schools for short intensive courses to fit them for special mechanical duties with our army and navy. These courses were quite successful and men who had been selling ribbon, or or who had been engaged in similar routine occupations most of their lives were taught to be motor or aeroplane mechanics in the short space of six weeks. The thought occurred to officials of the Institute that if education of this character could be so successfully used in war, it could probably be used with equal success in peace.

SOME NOTES ON FOUNDRIES AND PRODUCTION.*

By the Rt. Hon. Lord Weir of Eastwood, P.C.

When your good secretary, my old friend Mr. Greer, asked me to preside over this meeting to-night, I am afraid I consented under a misapprehension as to what was expected from me. I hardly understood that an occasion of this kind would demand a formal address of the technical character you are accustomed to, and I must tell you quite frankly you are not to expect it, because I have not been able to maintain my former close association with the technical side of affairs.

Accordingly it occurred to me in thinking over what I might say that a few reflections on the more commercial aspect of the foundry industry might not be out of place, and furthermore that I would not confine myself rigidly to non-ferrous foundries, but roam over the question of foundry productivity in general. Let me say that I would like you to regard this as a general talk rather than a formal address.

Allow me, then, in the first place to thank you for the honour you have done me in asking me to preside at your opening meeting, and allow me also to congratulate your local Committee on the energy and enthusiasm which has marked the formation and progress of the Scottish Section of the Institute of Metals. While Scotland has not been a leader in the actual production of non-ferrous commodities, yet it has been a very large and important customer for these products, and between the technique of production and the application of the product there lies an association of the most vital importance to the metallurgist and the engineer. I yield to no one in my appreciation of the value of pure research in chemistry and metallurgy, but I have never failed to grasp the supreme importance of technical research and development conducted under the allied auspices of the chemist and the engineer—a research which is only possible in the great laboratory of actual experience and use. Accordingly, I look for nothing but successful results from the activities of this Scottish Section which brings together those concerned with the technique of production and the technique of application.

Now, Gentlemen, at no time was the subject of production in general, of such vital importance as to-day, and I offer no apology for dealing with it in an assembly such as this where the broad economic issues are understood, and where the importance of our industrial efficiency is recognised and appreciated. Last week when speaking to the Glasgow Chamber of Commerce I dealt with production in its broadest aspects and with certain of the causes which limited the industrial performance of this country. To-night I will deal with a few of the narrower questions connected with production in our British foundries.

It is a very depressing fact that, due to many causes, our production of engineering commodities for the world's market in the post-war period has fallen lamentably behind the demand from that market, and perhaps graver still is the tendency at the present moment for demand to slacken off in view of the wild enhancement of costs and prices. It must always be remembered that our country is dependent on its industrial production for the support of its population. We pay for our imported food and raw material by the products of our industry, and our exchange and credit depend directly on its industrial performance. We have only two alternatives to production—one is emigration, the other a reduced standard of life.

Now in our production of engineering commodities the part played by our foundries is a most important one, and since the Armistice it is the case that our engineering output has been to a very substantial extent restricted by lack of supply of castings. In fact, the supply of these has been the limiting factor in our engineering production. We have experienced, and are still experiencing the extraordinary phenomenon of a shortage of castings in a great engineering country, and our engineering industry has suffered and is suffering very severely from the influence and interactions of that phenomenon. One of the causes for this is really an inheritance from the war period which brought about a lack of balance in the engineering facilities of the country. During the war we witnessed a vast expansion in machining and assembling capacity through the erection of war machine shops and the vast installation of machine tools required for munition purposes. These were largely employed on steel products, and now in peace they have been turned over to requirements which demand production in iron and brass. Accordingly, we have the phenomenon of lack of balance, and of machining and assembling facilities standing idle and the resultant position of restriction of employment.

Naturally such a case could be remedied by the rapid provision of new foundry facilities and by the conversion of certain types of war shops into foundries, and to a substantial extent this has been carried out. But facilities by themselves are insufficient. Labour is required, and here we find a parallel to the ill-balanced facilities. We have a bad balance of labour—a grave shortage of skilled moulders.

Now I wish clearly to enunciate the only four methods of improving the volume and efficiency of production in *any* industry. These four methods are as follows:—

* An address delivered before the Scottish Section of the Institute of Metals on Wednesday, October 27, 1920.

1. An increase in intensity of effort per operative hour.

2. An increase in the number of operative hours per individual per day.

3. An increase in the number of operative individuals.

4. A perfecting of methods, processes, and organisations, thereby eliminating waste of operative hours.

To-night I wish to disregard the first two as unsuitable for discussion on this occasion, and I shall deal very shortly with No. 3 and practically confine my attention to No. 4 which may be taken to represent the vital responsibility of the foundry employer and management.

In regard to No. 3, the gravity of the situation produced by the shortage of castings has been repeatedly emphasised and made clear, yet the Trade Union concerned in Scotland has rigidly set its face against the introduction and training of unskilled men and women in the foundries, and the same authority has been equally rigid in its opposition to payment by results which represents one of the most hopeful methods of improving output and efficiency. To-night I will not deal with these matters but confine myself to the question of perfecting methods, processes, and organisations in connection with foundries so that waste of operative hours may be eliminated.

I do not think you will disagree with me in my opinion that, while machine shop and other departments of the average British engineering shop have had much time, careful attention and enterprise devoted to the betterment of methods and processes, the foundries as a general rule have suffered severely from lack of this attention. I will go so far as to say that the present unsatisfactory position of the foundry industry is to a large extent the fault of employers' past policy, which has been the almost universal failure to appreciate the importance, necessity, and great possibilities of precise, accurate and scientific methods in the foundries. I believe that during the last few years there has been a considerable degree of enlightenment on the part of employers in this connection, and all this requires at the present stage is a recognition of this enlightenment by the Trade Unions and an elasticity of their policy and a sympathetic spirit of co-operation on their part to enable matters to be put right. Such co-operation would be of inestimable value, not only in overcoming the peculiar type of opposition and suspicion now met with in connection with the initiation of new methods which is largely due to prejudice and tradition, but also in dealing with the directly practical aspect of the many difficult problems involved. It is a matter of the utmost regret that practically no response has been made to repeated efforts to secure the interest and assistance of the union. No reflection whatever is made on the actual workers in this connection, because I believe that the relations, which are bad, are not the relations in the individual workshops between the workers and the management. I have a strong impression that in the shops the human influence exists perhaps healthier and stronger than ever, but this influence is to-day imprisoned and without opportunity to expand and do its valuable work.

Let me point out a peculiar phase of the moment, which is the tendency on the part of firms and individuals to organise new foundries and generally to extend the existing foundry facilities without making any provision for the necessary increase in labour. This policy must be unsound so long as the total number of operatives is strictly limited. The distribution of these skilled men over a greater number of foundries will not only decrease production in the bulk but will inevitably increase the cost of production taken over the country as a whole. It follows therefore that any rational extension of foundry facilities, if it is to be a real benefit to the industry and to the community, must imply some attempt to overcome the situation I have outlined through radical departure from traditional methods. A close investigation of the problem leads to the emergence of certain broad and general considerations which I propose to put before you. You will, of course, understand that, while my remarks apply in a general sense to all foundries, they will naturally have special reference to foundries engaged in the production of castings for engineering purposes.

The problems to be faced are many and varied, technical, commercial, and human; also most of them are hydra-headed in nature, and the organisation necessary to handle and solve them requires careful study and infinite patience. I have here a diagram (not reproduced) showing a skeleton organisation such as might be applied to a foundry engaged in the supply of castings on a large scale for engineering purposes. The organisation is two-sided, technical and commercial, each side having the necessary subsidiary branches and each having its own peculiar problems to solve.

Dealing first with the technical side, I would direct your attention to what I believe to be two of the fundamental defects of existing foundry organisations. The first is the somewhat well-known complaint among foundrymen that many foundry troubles originate in the drawing office or design department owing to comparative ignorance of foundry practice on the part of the drawing office personnel. The second is that many other troubles arise from defects in pattern shop practice. Let me say that the old system, which is substantially to-day's system, under which the foundryman sees the pattern and core boxes for the first time when they come to the foundry, is radically bad. It is a system which inherently means that the foundry methods, as defined by the particular arrangement of patterns and core boxes, have been predetermined by the patternmaker, and the influence and effect of bad design on foundry cost has only been subjected to the casual and somewhat irresponsible review of the patternmaker. Accordingly, to whatever extent the patternmaker's conception and solution of the problem is unsatisfactory, then to that extent additional responsibility has been imposed on the moulder's craftsmanship and capacity. In this way an abnormal degree of craft skill and ingenuity is imposed on the moulder—and when I speak of the moulder I also include the coremaker. Looking at it from another angle, the present system imposes an abnormal responsibility on the patternmaker, because we are entrusting him with almost the full responsibility for devising the process and method which is to be used in the foundry.

Taking these two phenomena together, we find ourselves demanding from the two operatives a knowledge and degree of craft skill which we cannot expect to be in keeping with economic success. Accordingly a close survey of the general conditions seems to indicate that some independent authority is required to investigate each problem from the foundry point of view, and to place the impress of foundry experience on both engineering design and pattern shop practice. This can be most conveniently carried out by means of a separate department, which might be termed the foundry planning department. This department would be manned by a staff of engineers in close touch with the foundry on the practical side. As its name implies, its function is, broadly speaking, to plan beforehand every foundry operation not only in its widest, but in its most detailed aspects. Its scope embraces the entire range of foundry technique, the study of methods, processes, and facilities, the design of patterns, core boxes, tools and appliances. On the completion of a design by the engineering department, the latter would, before issuing the drawings to the machine shop, send preliminary copies of these drawings to the foundry-planning department. These drawings will show full details of the castings required, and will also indicate the class of manufacture contemplated. This may range from the manufacture of a single casting to full mass production of standardised articles. It is the business of the planning department to scrutinise these drawings from the foundry standpoint. This scrutiny is, broadly speaking, a critical survey of the suitability of the design for actual manufacture in the foundry, and to be effective must obviously be carried out by a department thoroughly conversant with the foundry practice and resources of the firm. The degree or extent to which this investigation will proceed is, of course, entirely dependent on the class of manufacture. If only a single casting of a given type is required, it is obviously sound policy to economise on pattern shop costs to the utmost degree, so long as this may be carried out without giving rise to relatively greater costs in the foundry. The function of the planning department ends in this case when this policy is assured. On the other hand, if full mass production of a given casting is required by unskilled labour, a relatively heavy initial outlay on the design and installation of the proper equipment may in the end be essentially true economy.

Between these two extremes there may be an almost infinite variety of conditions demanding special consideration. Perhaps the most interesting duty of the foundry planning department is the study and evolution of the methods of mass production by unskilled labour. The importance of mass production has been fully realised by most industrial communities but the subject, so far as foundry practice is involved, has not yet received in this country the attention it undoubtedly merits. Our American friends, unhampered as they have been by restrictions on the dilution of labour, have certainly out-distanced us in its application to foundry work.

Mass production implies the manufacture in large quantities of sound castings true to shape and true to weight. Freedom from variation in shape is called for by modern machine shop requirements and methods of jigging and machining. Where castings are being made in large quantities, a slight initial overplus of weight will obviously become a serious economic factor in the mass, particularly in those days when high metal prices form an increasingly serious element in costing. The problem before the foundry planning department is therefore to secure these desirable results with the extremely important and, in fact, vital "addendum" that unskilled labour only be employed in the process. The first step is the rigid scrutiny of the design, to which I have already referred, with a view amongst other things to eliminating those inequalities in thickness of metal which produce or tend to produce that bogey of the foundrymen, namely, "drawn" metal. In conjunction with this scrutiny the general method of moulding, coring and closing, is carefully considered and settled. This investigation usually reveals some changes in design which are desirable from the foundry point of view to assist in obtaining production. These proposed changes are now placed before the designing department, who may accept, reject, or modify them, or propose alterations. This procedure is carried out until after, it may be, many vicissitudes the final form of the casting is agreed by both departments.

I need hardly dilate on the bearing and extreme value of this procedure on the work and education of both departments. The drawings of pattern and core boxes are usually prepared concurrently with the examination of the design, and this immediately involves the consideration of the material of which the various parts will be constructed. The materials in common use are wood, cast-iron, gunmetal, and aluminium, and many considerations affect the choice. Usually for mass production purposes patterns and core boxes will be of metal although in special circumstances wood is permissible. For core box work metal is almost essential so as to obtain, with consistency, the accurate fits which are absolutely necessary if the times of coreing-up and closing moulds are to be reduced to a minimum. While the design of metal patterns is relatively easy, important problems may be discovered in planning the core boxes. It is essential that these should be of as simple and rugged construction as possible; the design must provide for simple removal of the core from the box; it must also be satisfactory from the machine shop point of view, that is, it must not be too difficult to manufacture; lastly, and by no means least, it must be "fool proof" and easy to handle. On the table you will find two sample sets of patterns and core boxes as examples. The complicated casting required is moulded and closed in 19 minutes in place of 155 minutes on old system.

Following the completion of the designs of pattern and core boxes, attention is then devoted to the actual plant for manufacture. This involves a careful study of moulding methods—the type of machine to be used, whether hand ram, jar ram, squeezer, or other type—also the design of moulding flasks exactly suitable to the conditions of the work. Methods of gateing and pouring are also important and must be standardised.

The problem in its last phase involves the study of the moulder and coremaker himself, the provision wherever possible of apparatus or tools to assist him in rapid execution under the best conditions. Special appliances may be provided for accurate and rapid core setting; these are usually of the template form. The energy of the moulder is economised by careful motion study to eliminate useless work, and the results are available to him in the form of a list showing the complete cycle of operations from commencement to completion of the job.

You will notice that I have placed the pattern shop and foundry tool room in close relationship to the foundry planning department, and this is undoubtedly required for efficient working. The work of the foundry tool room is of necessity devoted very largely to the machining and finishing of patterns and coreboxes, and success in the foundry is largely dependent on the quality of this work. Great care and attention must be given to secure from both patterns and coreboxes the "perfect draw" which is essential if real economies are to be effected in manufacture. Nothing short of perfection in this respect is of any use in plant for repetition work. On no account should the operator be under the necessity of "touching up" or repairing either mould or core after it leaves the machine, as this leads to great waste of time and is extremely unsatisfactory from the point of view of both employer and operator.

Reverting now to the commercial side of the diagram, we are led to the consideration of the particular type of organisation required to reveal clearly and accurately to what extent the efforts of the technical and works staff have been successful. It is undoubtedly true that in the past the importance of a scientific system of works accounting, having special reference to foundry practice, has not been universally appreciated, but the advent of the casting shortage, combined with the extraordinary increase in productive wages and cost of materials has gradually focussed attention upon the subject. These factors, along with the necessity for increased production, and, what is economically of much greater importance, *cheap* production, at once elevate the subject of foundry costs to a position of prime importance. I need hardly emphasise the fact that before cost of production can be diminished, by improved methods or otherwise, the precise cost of the article in question must first be accurately known and, further, must be accurately known in detail. Then, and only then, is the investigator in a position to judge the validity of suggested improvements. It is a more or less common experience that, in many cases where proposals to substitute new methods for old have been originated, and where new methods appear to indicate undoubted technical improvement, a close scrutiny of the detail costs shows that, when all factors are considered, the new method is not commercially superior to the old. It is evident, therefore, that works costs must occupy a prominent place in the activities of the foundry accountant, and further, the aim of the foundry superintendent being to secure the maximum of attainment with the minimum cost, it is desirable that at regular intervals the accountant should place before him a comparative analysis of the cost accounts so that he may be able to investigate existing methods or definitely locate leakage losses.

As illustrating this aspect, a close examination of the wages costs of various operations may reveal inefficiency—actual or relative—not necessarily on the part of the workman, but possibly of the methods or plant employed. Such inefficiency being clearly demonstrated, the case immediately becomes one for investigation of method by the planning department. The comparative analysis should show also the costs of the various processes, from the charging of metal into the cupola until the despatch of the completed article, so that the whole activity of the foundry may be constantly under review. Other aspects dealt with would be:—Cost of inefficient workmanship, defective products, excessive consumption of fuel or shop supplies, lost time due to breakdown of plant, structural alterations, delays through non-delivery of materials, climatic conditions or other causes.

In arriving at true costs, however, perhaps the most important and difficult aspect of the work of the foundry accountant is the allocation of oncost charges. The rational allocation of these charges is, without doubt, the master clue to useful, practicable, and accurate foundry costing. Careful study must be given to each oncost charge to ascertain to which element of cost it is actually related and with which it should naturally vary. Certain oncosts are incident in drysand work only, others are incurred exclusively with greensand or loam work. The system must provide for their proper distribution over the output of these classes of castings. Further, certain classes of expenditure, such as sand charges, naturally vary in proportion to the weight of the castings handled, whilst other charges, such as those for supervision or electric lighting, are directly related to productive wages or productive hours, and will vary accordingly. The organisation must be such that the data required to build up these charges is continually collected. This implies a closely linked-up system

enclosing in its network the purchasing department for outside supplies, the stores department for inside charges, and the despatch department for the issue and return of material. The scheme may, of course, vary considerably according to the class of foundry, but I think I have outlined the essential features. One factor which might produce considerable modification would be the introduction of a system of payment by results to supplant the usual time rates. I need hardly insist on the value, alike to employer and employee, of the existence of an accurate system of detail costing before such a change is made, and, from another standpoint I feel certain that not the least of the benefits which would accrue from the introduction of payment by results in the foundry would be its tonic effect on the costing system leading to a general tightening of all statistics. Naturally, in such circumstances also, the methods of allocating oncost would require review in the light of the new conditions.

It must, of course, be obvious to you all, Gentlemen, that the organisation which I have briefly outlined will be of but little value unless every effort is made to correlate it with high efficiency and the best obtainable conditions in the foundry itself. Office organisation, technical or commercial, however perfect in design and detail, will not produce castings. The requirements in the foundry with regard to design, lay-out, and operation planning, are extremely important. In fact, where mass production is contemplated, I would almost say that the degree of perfection realised in these respects determines the degree of success. The exceedingly wide scope of the subject, however, makes it impossible for me to do more than touch the fringe. The conditions of bodily comfort of the worker, such as heating, lighting, and ventilation, will naturally demand close study. In view of the comparatively dirty nature of the work, general welfare conveniences will be regarded in a very liberal sense. The construction of the floor is important; a complete concrete floor is not suitable for all foundries but, where feasible, it offers certain very decided advantages. It is clean and leaves the mould level; it has a smooth surface, and is favourable to the use of sand cutting machines of the portable type. Modern foundry transport when carefully planned tends to gravitate to the floor, and where the latter has a suitable surface this seems to me to be sound practice as compared with the use of overhead cranes, which on this type of work are undoubtedly extremely wasteful due to the lift necessary for clearance only, also to the very large proportion of time in which they must of necessity journey unloaded. Floor transport must be provided for by the laying down of definite alley-ways on the foundry floor which remain always clear. These alley-ways or work routes correspond in direction to the natural drift of the material in the course of manufacture. Tractive power for transport may be provided by electric or petrol trucks, and, properly designed, very high speeds can be obtained. In order to eliminate labour charges to the utmost degree possible, every function of transport must be catered for from the introduction of the raw material to the removal of the finished product and the refuse.

Mass production on modern lines implies the use of "greensand" in very large quantities for moulding purposes; the daily handling of large masses of this sand, also its treatment by screening or cutting must be carefully considered. The cost of carrying out work of this nature by hand labour is very great, and in the past many elaborate and costly plants have been laid down to overcome the difficulty. Machinery of the type required for this work is usually extremely expensive in both first cost and upkeep, and the tendency of modern practice is to strike a mean between hand labour and very elaborate conveying and treating systems, by treating the sand *in situ*, as it is knocked from the boxes after casting. This implies the use of portable sand hand machines or alternatively of special machines attached to the separate foundry machine units. In any case where well made patterns are used, moulding machines will certainly be employed, and where the nature of the work requires overhead crane service for handling foundry boxes, the best arrangement seems to be to divide the foundry into units or groups of machines, each having its own crane. These cranes would have a strictly limited travel longitudinally, and in this respect would serve only a section of the floor or a group of machines. The alternative is an overhead travelling crane system with a range covering the whole foundry, but experience seems to show that the attempt to exact an overall service from an arrangement of this kind leads to inevitable delays where a number of "squads," or moulding machines, have to be catered for concurrently.

With regard to core room practice, the tendency is towards a special core-making department entirely separate from the foundry proper. Full advantage must be taken of metal coreboxes to obtain accuracy and interchangeability. For the larger cores, machine methods of manufactures will require to be developed. An interesting feature in core-making is the increasing use of high silica sand bonded with oil. The splendid venting properties of this combination and the excellent results achieved, leave no doubt as to the desirability of further development of its use. The arrangement for the supply of properly tempered and correctly bonded sand to the core-makers should be carefully planned. One method giving good results consists in delivering the mixed sand by chutes from an overhead gallery direct to the core-makers' benches. This ensures a continuous supply of fresh sand, and keeps the floor clear of sand heaps which again facilitates electric transport. The finished cores on suitable frames would be run direct from the core-makers' benches into the ovens. With regard to the ovens themselves, the essential problem is to secure that combination of correct temperature and air circulation which is productive of the most rapid baking conditions.

Lastly, by no means the least difficult problems to be faced in the modern foundry are the questions of labour and payment. With regard to these questions, I can only hope that, when the body politic is restored to a condition of economic sanity, as I sincerely hope it may be before economic disaster intervenes, these questions will be considered in the light of reason and commonsense.

The gear shown comprises the patterns and core boxes for 4½-in. piston valve chest, and while not representing very latest practice, substantial economies have been secured. This casting was formerly manufactured on a simple pattern drawing machine, using wooden patterns and hand ramming. The time of ramming up was two hours and the time of closing was 35 minutes. By the new method using metal patterns and core boxes, the moulding time per casting has been reduced to 15 minutes and the closing time to 5 minutes. This illustrates broadly the extent of the saving incident on the use of improved appliances.

In conclusion let me repeat that I have not attempted to give you any formal address, but merely to recite a few considerations to be kept in mind when fulfilling the responsibility which falls on a foundry owner to secure that degree of efficiency in matters still within his own control as will enable us to hold our position in the world markets.

THE INFLUENCE OF ANTIMONY AND ARSENIC UPON ADMIRALTY GUN-METAL.

*The Effect of Increasing Proportions of Antimony and of Arsenic Respectively upon the Properties of Admiralty Gun-Metal.**

By R. T. Rolfe, F.I.C., Member (the Metallurgical Research Laboratory, Messrs. W. H. Allen, Sons and Co., Limited, Queen's Engineering Works, Bedford).

The present paper describes some further work carried out in order, if possible, to clear up certain matters which as a result of previous work on the subject had perforce to be left in a somewhat unsatisfactory condition. The only previous work in which any experimental evidence is offered as to the separate effects on this alloy of these two impurities is that by Johnson and by the present author. The former refers also to the views of other writers on the same subject, but these appear rather conjectural, no data being given as to the grounds upon which the opinions are based. It is not proposed at the moment to rediscuss this earlier work, although various references to it are made later, where the results of the present research throw further light on particular aspects of the question. It may be said, however, that the question of reconciling the different views of Johnson and of the author was complicated by the differences in the experimental conditions, Johnson's work being on a very limited number of small chill-castings, while that of the author dealt with a great number of large sand castings on a foundry scale, where it was impossible to give very exact data as to the different compositions. In the end a considerable measure of agreement was arrived at, but it was obviously necessary to carry out further work before various points could be considered as satisfactorily settled, and the results of that work are here detailed.

In view of the importance of establishing, in the case of this standard alloy, which is used on an extremely large scale, the exact effect of the different impurities which may be found in it in commercial practice, no apology should be necessary for thus returning to the matter.

The research now being described deals with the effect of each impurity separately, a number of synthetic alloys having been prepared showing, in one series, a progressive increase of the proportion of antimony, and in the other of arsenic, both sand and chill castings being made side by side, while casting temperatures were determined and complete analyses were made of all the different compositions, these being correlated with the mechanical test results, soundness of castings, hardness and with the microstructures. Apart from the complete analyses of all the alloys, complete analyses were made of all the original constituent metals used.

In the case of each alloy, the residual metal from each melt, after the requisite sand- and chill-cast bars had been poured, was cast into ingots. These were later re-melted, without any addition being made, and further bars were cast, while again casting temperatures were determined and analyses made. This procedure afforded an additional check upon the influence of the particular impurity, and gave information as to the variation in composition caused by re-melting.

The Effect of Antimony.—Although this impurity sometimes occurs in commercial B.S. copper, it is usually through the medium of the tin that it is found in Admiralty gun-metal. The author has already put on record† analyses of commercial tin, showing that up to 6·70 per cent. of antimony may occur, and by the use of such a tin for the manufacture of Admiralty gun-metal, a proportion of about 0·67 per cent. of antimony in the alloy made from the same would naturally result. There is also the question of the use of antimonial scrap, which was fully dealt with at the same time. There is no question as to the possibility of proportions of antimony of the order of magnitude of 1 per cent. or even more being found commercially in the alloy in question. It remained, therefore, to establish its precise effects, and it was decided to make up alloys containing, respectively, no antimony, 0·5 per cent., 1·0 per cent. and 1·5 per cent. of antimony, in replacement of the tin. The descriptions and analyses of the copper, tin, antimony and zinc, respectively, that were used are subjoined: Copper—Messrs. John Bibby, Son and Co.'s best selected; tin—Messrs. Williams, Harvey and Co.'s "Lamb and Flag" brand; antimony—"H.G.S.W." brand, the makers of which are not known; zinc Messrs. Suzuki and Co.'s "Rising Sun" brand. (The respective analyses of these metals were given in the paper.) All the metals were of a good degree of purity. The antimony contained a little arsenic, but of a quite negligible amount when not more than 1·5 per cent. of antimony at the most was used. The brand of copper employed contained a little nickel, the proportion of which element was constant throughout the range of alloys. It was therefore considered that the nickel would have no appreciable effect upon the variation in mechanical qualities due to the antimony.

In the manufacture of the alloys a 50-lb. pot was used, the copper being melted first, the tin and antimony being then added, and the zinc last. The size of the bars, both sand and chill, was 1 in. in diameter by 15 in. long. The top 3 in. of each bar was cut off in the foundry, to ensure the removal of any piped material. Four bars were cast from each melt, two sand and two chill. The weight of the metal moulds in which the chill-cast bars were made was 26 lb., and the wall was about ⅝ in. thick at the top, increasing to 1½ in. at the bottom, and about 1½ in. thick in the actual base. These moulds were, as usual, heated before casting in order to get rid of moisture and avoid unsoundness. They were coated on the inside with boiled linseed oil. The sand castings were in greensand. The details of the different compositions aimed at, and the temperatures at which the bars were cast, were then stated. In this connection, reference may be made to the so-called "safety range" of casting temperatures, which is, as arrived at by Karr and Rawdon, between 1,120 deg. and 1,270 deg. C. for this alloy. With the results of these experimenters the work of Carpenter and Elam* appears to be in general agreement, although the latter authors did not test these precise limits. In two cases of the author's, the chill-cast bars from the melts were poured at temperatures slightly above the top limit of the range, viz., 1,280 deg. and 1,310 deg. C. respectively. As these particular casts do not show any unsoundness, nor any irregularities in the mechanical test results, the question of any variations in mechanical qualities being due to varying casting temperatures may be disregarded. All the author's other melts are within the safety range, which would appear from the present work to have an upper limit slightly higher than that arrived at by Karr and Rawdon.

The re-melts of the 1 per cent. and 1·5 per cent. antimony alloys were unsound when chill-cast. As in each case, the melts of these compositions were cast at a higher temperature than the re-melts, and were sound, one must again come to the conclusion that, in considering the differences in behaviour, variation in casting temperature as a cause of difference may be ruled out. The casting temperatures recorded were those of the metal in the shank ladle before pouring into the moulds, and were determined by means of a Foster pyrometer (nickel-chromium and nickel), reading to a little above 1,350 deg. C. The accuracy of the instrument was checked each time it was used against both a Féry radiation pyrometer and a Paul platinum, platinum-iridium pyrometer, no variation greater than 10 deg. C. being recorded at the temperatures at which it was operating. The way in which each bar was cut up for examination is shown in Fig. 1.

(The compositions aimed at, and the complete analyses of all the eight alloys that were actually obtained, four from melts and four from re-melts, are next detailed.)

In general, re-melting does not seriously alter the compositions of the alloys. The greatest variation naturally occurs in the zinc. The amount of zinc obtained in the melts varied between 1 per cent. and 1·5 per cent., as against a nominal figure of 2 per cent. It appears as if from 1·3 per cent. to 1·5 per cent. is about what one should expect. On the same basis, in re-melting, a further reduction to about 1 per cent. ought to take place. In one case, however, a proportion of some 1·5 per cent. of zinc in the melt is reduced in the re-melt to only a little over 0·5 per cent. This particular re-melt also shows a marked reduction in the tin, with the result that the copper is decidedly higher than in the melt. Apart from this one case, the proportion of tin appears little affected by re-melting, and the same applies to the antimony, the figures for which are also very close indeed to the proportions aimed at. Only traces of arsenic occur, while as regards the other impurities present these are not only fairly constant throughout the range of alloys, but are also not higher in proportion than is frequently found in commercial practice. It is therefore considered that this range of alloys should afford a good opportunity of judging the effects of antimony.

The Effect of Antimony upon the Mechanical Test Results. The 8-in. test bars for tensile purposes were machined to 0·798 in. diameter by 2½-in. parallel, for 2-in. acting length. It may be objected that this is an odd-sized test-piece, which does not conform to the usual formula, $L = 4\sqrt{\text{area}}$, which should correspond to an acting length of 3 in. The effect on the elongation figure of using such a test-piece is, however, negligible in the case of Admiralty gun-metal, because a test bar of this material when pulled in the tensile machine elongates evenly throughout its whole length before fracture, and does not neck-down in one place. Therefore, in a test-piece 0·798 in. in diameter, whether

* Abstract of a paper read before the Institute of Metals, at Barrow-in-Furness, on September 16.

† Journal of the Institute of Metals, No. 2, 1918, vol. xx, page 270.

* Journal of the Institute of Metals, No. 1, 1918, vol. xix, page 171.

the elongation is measured on 2 in. or 3 in. is immaterial. The same percentage elongation is obtained, and this fact has been frequently confirmed.

The tensile machine used was a 30-ton Buckton, while the approximate yield-points, no extensometer being at the moment available, were determined by hand in the usual commercial manner. (A table in the paper gives the figures for the antimony series.)

Some of the more interesting of the test-bars are as follows: Fig. 2, sand-cast antimony series, melt, $A1S_1$ and $_2$ to $A4S_1$ and $_2$, after pulling; Fig. 3, sand-cast antimony series, re-melt, $B1S_1$ and $_2$ to $B4S_1$ and $_2$, after pulling; (these show well the progressive falling-off in ductility of the metal with increasing antimony.) Fig. 4, chill-cast antimony series, re-melt, $B1C_1$ and $_2$ to $B4C_1$ and $_2$, before machining; these show a progressive unsoundness with increasing antimony, and will be referred to later.

The mechanical test results as a whole are plotted as graphs in Figs. 5 and 6, compared with the minimum figures laid down by the Admiralty specification for this material, viz., an ultimate stress of not less than 14 tons per square inch., with a minimum elongation of 7·5 per cent. on 2 in.

It should be noted that one of the two sand-cast bars from the melt of the 0·5 per cent. antimony alloy gave abnormal results as regards ultimate stress and elongation. As the results from the companion bar were confirmed by those from the two bars of the re-melt, and as the results of the whole series were otherwise quite consistent when correlated with the progressive increase in antimony the figures from this abnormal bar, although they have been plotted on the diagram, have been disregarded in drawing the curves.

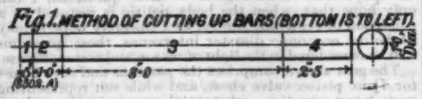
Taking first the results from the sand-cast material, it will be seen that antimony is a prejudicial impurity, which progressively causes a falling-off in both the strength and ductility as its proportion increases. With 1 per cent. of antimony, the ultimate stress figure approximates to, while the elongation figure falls just below, the minimum figure laid down by the Admiralty specification. While, therefore, in the sand-cast gun-metal, the less antimony the better, the maximum permissible amount of this impurity might be placed at about 0·75 per cent.

It will be noticed how, in the melts, the ultimate stress and yield-point figures are a little higher, and those for elongation a little lower, than in the case of the re-melts, but that there is really for all practical purposes very little difference between them. There is a belief among foundrymen that a considerable improvement in the mechanical qualities of this alloy is obtained from re-melted metal, as compared with that made originally from its constituents. Whether there is much in this belief, the author has always been rather inclined to doubt, and the present instance does not lend much support to the theory. In the case of arsenic a curious result was obtained in re-melting, which does to some extent confirm this idea.

In chill-cast gun-metal the same tendency, with increasing proportions of antimony, towards a regular falling-off in the ultimate stress figure is seen, and possibly also to some slight extent in the elongation. The extent to which chilling masks the prejudicial effect of antimony is shown by the much greater flatness of the curves. The tendency of the yield-point figure, with increasing proportions of antimony, is to increase and to approximate more closely to the maximum stress figure.

The paper compared the figures obtained from the

Fig. 1. METHOD OF CUTTING UP BARS (BOTTOM IS TO LEFT).



(1), micro-piece; (2) Macro-piece; 3, tensile bar; 4, reserved.

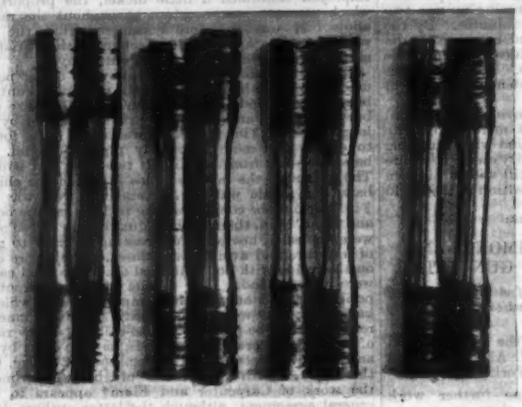


Fig. 2. Sand-Cast Antimony Series (Melt), after Pulling.

The test-bars are, from left to right in pairs, as follows: $A1S_1$ and $_2$ (no antimony), $A2S_1$ and $_2$ (0·5 per cent. antimony), $A3S_1$ and $_2$ (1·0 per cent. antimony), and $A4S_1$ and $_2$ (1·5 per cent. antimony).

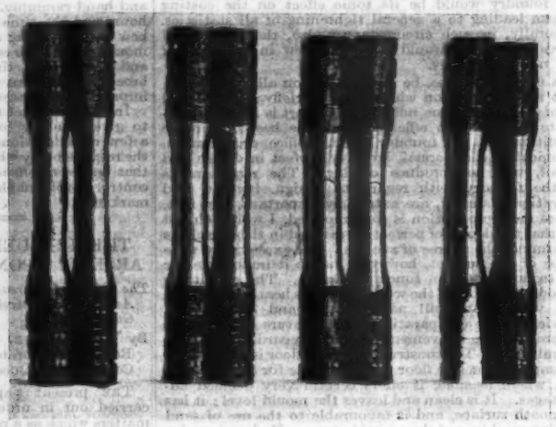


Fig. 3. Sand-Cast Antimony Series (Re-melt), after Pulling.

The test-bars are, in pairs from left to right, as follows: $B1S_1$ and $_2$ (no antimony), $B2S_1$ and $_2$ (0·5 per cent. antimony), $B3S_1$ and $_2$ (1·0 per cent. antimony), $B4S_1$ and $_2$ (1·5 per cent. antimony).

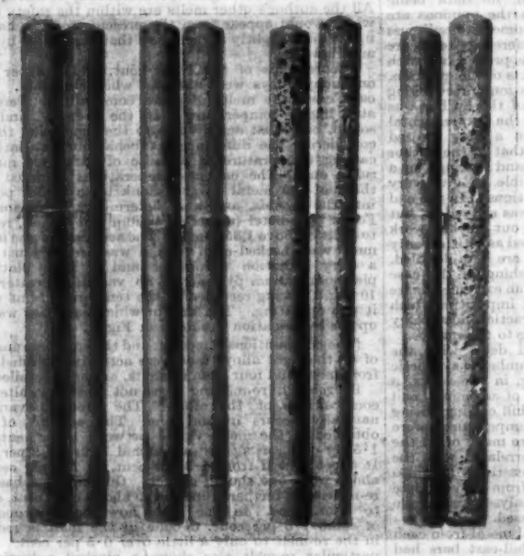
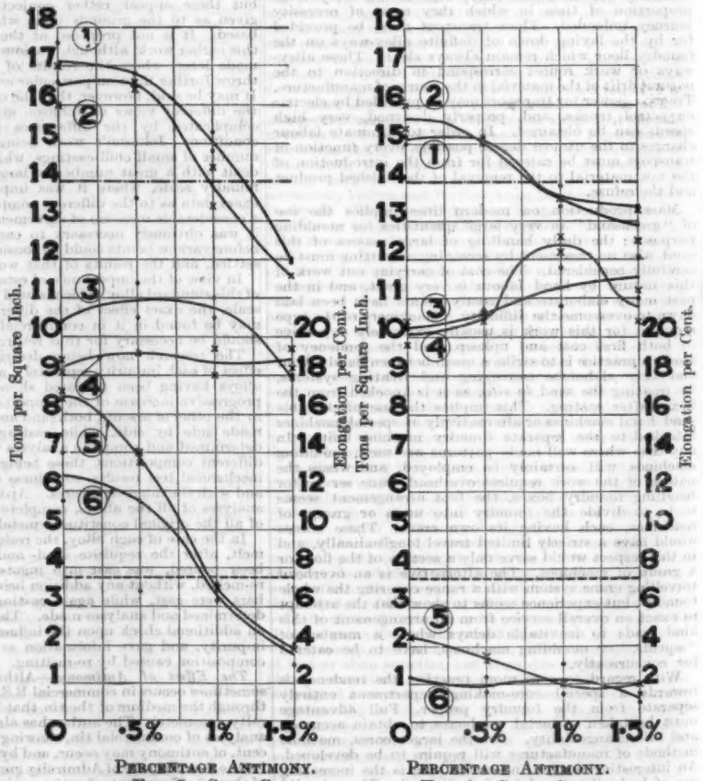


Fig. 4. Chill-Cast Antimony Series (Re-Melt), before Machining.

The test-bars are, in pairs from left to right, as follows: $B1C_1$ and $_2$ (no antimony), $B2C_1$ and $_2$ (0·5 per cent. antimony), $B3C_1$ and $_2$ (1·0 per cent. antimony), $B4C_1$ and $_2$ (1·5 per cent. antimony).



Curve (1), representing ultimate stress (melt); curve (2) representing ultimate stress (re-melt); Curve (3) representing yield point (melt); curve (4) representing yield point (re-melt); curve (5) representing elongation (re-melt); curve (6) representing elongation (melt); ——, representing Admiralty minimum figure for ultimate stress; – – – –, representing Admiralty minimum figure for elongation per cent.

1 per cent. antimony alloy in the present research with those obtained by Johnson* in the case of chill-cast gun-metal containing the same proportion of this impurity, and the author said it appeared that the mechanical qualities of Admiralty gun-metal in the chill-cast condition are largely affected by the degree of chilling. Thus, judging by Johnson's results, which it must be remembered were from small slabs ½ in. thick by 4 in. long by 3 in. deep, very drastically chilled. Section 1 being cut from the bottom of the ingot, while Section 2 was higher up, a great falling-off in the figures for ultimate stress and elongation occurs under the less violent chilling obtaining in Section 2 of the ingot. In the case of the author's results, where from the general conditions one would expect rather slower conditions of cooling, both the ultimate stress and elongation figures are very much lower than even the Section 2 results of Johnson. The results are really hardly comparable and this emphasises the need of obtaining the same experimental conditions before one can hope to reproduce exactly the results of any previous investigator. In the light of the author's figures, however, it would appear a little optimistic to expect from chill-cast gun-metal containing 1 per cent. of antimony figures of the order of magnitude of 23 tons tensile strength with 28 per cent. elongation, except of course after annealing.

The Effect of Antimony upon the Soundness of the Castings.—No differences in this respect were observable in the case of the sand-cast bars containing various proportions of antimony.

The same remarks apply to the chill-cast bars from the melts; but in the re-melts, with an increasing proportion of antimony was associated a much greater unsoundness. This is particularly well shown in Fig. 4, where it should be noted that the bottoms of the bars are at the top of the photograph. It is a little curious that there should be no indication of this unsoundness in casting the first time. As the conditions were standardised, and as precisely the same phenomenon is seen in the chill-cast arsenical bars of the re-melts, but not of the melts, it would appear to be a definite effect which may occur with either of these two impurities, and for which effect in re-melted metal neither the compositions nor the casting temperatures afford any explanation.

For this reason one must regard antimony in chill-cast gun-metal as a prejudicial impurity, which progressively causes an increase in the unsoundness of the castings, first showing this tendency to a pronounced degree in the case of the 1 per cent. antimony alloy. While therefore, in chill-cast gun-metal, the less antimony present the better, the maximum permissible amount of this impurity appears to be in the region of 0·75 per cent.

The same limiting proportion of antimony appears, therefore, to apply in either sand or chill-cast gun-metal, although the reasons relate to a falling-off in strength and ductility in the sand cast, and of strength and soundness in the chill-cast material.

(To be continued.)

South African Engineers' Directory.—We have received a copy of this book, the full title of which is *South African Engineers' Electrical and Allied Trades Directory*, which is compiled by the *South African Mining and Engineering Journal*. It can be obtained from Mr. L. Hewson, 56, Ludgate Hill, E.C. 4, at the price of 30*s.* net. It is divided into six sections. It gives information on all South African engineering concerns, their class of trade, capital, the names of the directors and addresses, arranged alphabetically under the titles of the companies, and geographically. Another section deals with the overseas manufacturers, giving their specialities and the names of representatives in South Africa. The book will be found of great help both by South African firms and by British manufacturers who trade with the various South African centres.

Separation of Atmospheric Oxygen and Nitrogen.—In our references to the production of helium from natural gas and to the American experiments in this field we mentioned that three processes were used: a Linde process, a Claude process, and the Jefferies-Norton process. Experiments with the third were last year said to be proceeding. In *Chemical and Metallurgical Engineering* of September 15 last, pages 511-518, Frederick E. Norton explained this third system. He dwells on the industrial possibilities of oxygen and maintains that the liquefaction of air is an easy matter provided that all water vapour and carbon dioxide be first removed from the air. All the processes in use, however, he asserts, are defective, and hence inefficient, in two respects. The air is made to expand at very low temperatures so that the primary compressor work is totally lost and the air is distilled by the introduction of external heat. How the defects may be remedied by a modification of the cycles without apparent changes in the mechanical processes and in the apparatus he describes at some length by the aid of diagrams, including an entropy diagram. He makes use of auxiliary cooling and of a throttle of special type, but avoids the liquefaction of air by the cooling effect of nozzles or expansion engines. It would be impossible, however, to give a description of the system in a few lines. He speaks of seven years of experimenting without mentioning the helium experiments, and he seems to be anxious to explain the largely misunderstood principles of the liquefaction and separation of gas mixtures for the purpose of securing general support for researches on the isolation of atmospheric oxygen.

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*Journal of the Institute of Metals, No. 2, 1918, vol. xx, pages 176 to 177.

CATALOGUES.

Balata Belting.—A revised table of prices of balata belting, subject to discount, has been issued in convenient form by Messrs. John Tullis and Son, Limited, Glasgow.

India Rubber Goods.—A catalogue of fabric, insulating, hoaing, packing and practically all kinds of rubber and waterproofed goods, has been issued by the Ioco Proofing Company, Limited, Anniesland, Glasgow, now an associated company of Messrs. Vickers, Limited.

Cement.—The Fabrique Argovienne de Ciment Portland, Holderbank-Wildegg, Switzerland, send a handsome illustrated catalogue showing views of the locality, buildings and machinery of their works, and quoting the results of tests of their Portland cements.

Cast-Iron Pipes.—The Stanton Ironworks Company, Limited, near Nottingham, continue to issue their monthly list of spigot and socket, flanged and hydraulic pipes in stock for immediate despatch, giving full particulars of sizes and quantities.

Oil Engines.—A range of oil engines, from 50 h.p. to 1,000 h.p., open and enclosed types, and suited for all classes of land and marine work, is shown in the revised edition of the catalogue issued by Messrs. Hicks, Hargreaves and Co., Limited, Bolton. The construction is fully explained, and much useful information is given.

Concrete Flooring.—A metallic preparation for mixing with Portland cement to produce an oil-proof and waterproof surface on floors is described in a catalogue issued by Building Products, Limited, 44, King's-road, London, S.W. 3. Exceptional durability under traffic is claimed for it.

Small Oil Engines.—Small engines running on paraffin oil are largely imported and Messrs. Petter, Limited, Yeovil, are making engines to compete with these. Their catalogue shows three sizes, the horse powers of which are 2½, 5 and 8. The engines are fitted up for stationary or portable use and all parts are standardised.

Electric Lighting.—Factory and street lighting are specially treated, on their technical side, in a catalogue issued by the General Electric Company, Limited, 67, Queen Victoria-street, London, E.C. 4. The introductory matter is clear and informing, and is followed by a fully illustrated list of lamps, brackets, reflectors, switches and all necessary fittings.

Boilers.—A new edition of their steam boiler catalogue has been issued by Messrs. Holdsworth and Sons, Limited, Leeds-road, Bradford, whose products include all land types. The "Yorkshire" boiler, introduced some thirteen years ago, continues to find favour under the test of practical experience. Some interesting figures of evaporation trials and much useful technical data are given in this catalogue.

Steam Tables.—A series of four steam tables has been printed in clear type in a 12-page catalogue issued by Messrs. Ed. Bennis and Co., Limited, 28, Victoria-street, London, S.W. 1. The tables give the temperature of steam at various gauge pressures, the total heat of saturated steam and water, and factors of equivalent evaporation. Full instructions for using the tables are included.

Electric Motors and Condensers.—The British Thomson-Houston Company, Limited, Rugby, have issued a 24-page catalogue of synchronous motors and condensers. There is an introductory chapter on the effect of lagging power factor, an explanation of the commercial and technical advantages of the machines, and a detailed description of the construction which will be extremely useful to engineers.

Boring Cutter.—Messrs. Vickers, Limited, Sheffield, send two catalogues describing the construction and use of, and the method of, re-hardening a new boring tool or boring head. The cutting slopes are stepped, the cutter floats on the front of the boring bar, and there is provision for forced lubrication through the bar. The standard sizes run from 2½ in. diameter to 12 in. diameter. Some quick boring results are quoted.

Steam Turbines.—The De Laval Steam Turbine Company, 150, Southampton-row, London, W.C. 1, send a catalogue containing a statement of the advantages of steam turbines in comparison with reciprocating engines and illustrating the firm's own turbines and reducing gears. Examples fitted in warships and merchant vessels are shown, and some finely-printed sectional drawings are attached.

Electro-Medical Apparatus.—Two interesting catalogues have been issued by Messrs. Watson and Sons, (Electro-Medical), Limited, Parker-street, Kingsway, London, W.C. 2; one containing a series of priced lists of X-ray installation suitable for various purposes, and the other dealing with diathermy apparatus. Diathermy is defined as the use of electrical currents to raise the temperature of the body in the treatment of disease.

Blast Furnace Gas.—An instructive eight-page pamphlet discussing the economical burning of blast-furnace gas has been issued by Mr. J. E. Weyman, Pilgrim House, Newcastle-upon-Tyne, who has evidently given careful attention to the difficulties of effecting the necessary mixture with air when low and varying pressures have to be dealt with. Mr. Weyman states that the previous average efficiency of burning was about 40 per cent., and that by his system an average efficiency of about 75 per cent. may be attained.

Refrigeration.—Refrigerating and ice-making apparatus of the ammonia absorption type, which is operated by the simple application of heat, without moving mechanism, is described in a catalogue entitled "Revolution in Refrigeration," issued by the British Refrigerating Company, Limited (associated with Messrs. Vickers, Limited), 37, Tothill-street, Westminster, London, S.W. 1. The system may be continuously operated with two or three generators, and the apparatus is made in units suitable for domestic trading, industrial or marine use; and also for road vans and railway wagons.

Valves.—Steam and water valves of the sluice form are shown in a catalogue from the Clayton Valve Company, Limited, Preston Old-road, Blackpool. The valve stem is in axial line with the piping and the valve disc is moved by means of a screw lying in the same axial line and operated through bevel gears by the usual hand wheel. The screw and bevels are enclosed against direct contact with the steam or other fluid inside the valve body. The diameter of the valve body does not exceed that of the flanges, and the packing gland and hand wheel project much less than in the more usual types of valve.

Potentiometers.—Explanations of methods of measuring direct currents and electromotive forces by means of potentiometers, with illustrated descriptions of a series of instruments covering a great variety of practical applications, are given in a catalogue issued by the Cambridge and Paul Instrument Company, Limited, 45, Grosvenor-place, London, S.W. 1, who also send a neat little 72-page booklet containing descriptions of a large range of their instruments for engineering works and laboratories as exhibited at Olympia in September.

Oil Engines.—Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, 3, Woodstock-street, Oxford-street, London, W. 1, send a special catalogue of marine oil engines of both four-cycle and two-cycle types which they are building at Newcastle-on-Tyne for mercantile ships. The designs and patent rights of Messrs. Sulzer Brothers, Switzerland, have been secured for use by Messrs. Armstrong. The two-cycle type will work on Californian and Mexican crude oil, which is a comparatively cheap fuel but is unsuitable for four-cycle engines owing to its sulphur and asphalt contents. Messrs. Armstrong's object has been to produce an engine which will work on any oil fuel that may be available at ports in any part of the world. The explanatory matter is clear and well arranged.

Turret Lathes.—An unusually interesting catalogue dealing with turret lathe work comes from Messrs. Alfred Herbert, Limited, Coventry. The aim is to show the kinds of work for which turret lathes are suitable, the outfits of tools for repetition work and the methods of chucking and steadying pieces which present unusual difficulties. Over 100 illustrations are given, with sufficient notes to make the method clear in each case. The lathes dealt with are the "combination," "capstan" and "hexagon," all of which have hexagon turrets, and an automatic lathe which has a four-tool turret and a two-tool-box cross-slide. All these are powerful machines capable of both heavy cutting and fine accurate work. The self-centring chuck plays an important part in these methods, and is more fully described in a separate catalogue entitled "Concentric Chucking."

Middlesbrough Pig-Iron Shipments.—Messrs. William Jacks and Co., 5, East India-avenue, E.C., state that during October the pig-iron shipments from Middlesbrough, including Skinningrove, were 13,226 tons coastwise and 13,009 tons foreign, a total of 26,235 tons, as against 44,134 tons in September last, 20,541 tons in October, 1919, and 29,092 tons in October, 1918.

Industrial Welfare Society.—The second annual general meeting of this society took place on October 29, when the second annual report, for the year ended June 30, 1920, was read. The opening speech was made by the president, H.R.H. The Duke of York, K.G., who said the report, to his mind, was a most satisfactory one, since it showed a wonderful record of progress made, and held out the prospect of still greater work. Sir William Beardmore, the chairman, who also spoke, said the most interesting feature of the year's work had been, he thought the growing recognition of the usefulness of the welfare movement amongst the adult workers of the country. The women's side of the work required the society's careful attention, for the welcome given to the society's endeavours made it imperative upon them to enlarge operations in that direction. We may add that the society's offices are 51, Palace-street, Westminster, S.W. 1 and in sending us a copy of the report in question, the director states that industrial welfare work is quietly making its contribution to the solution of many problems which hinder our national progress.

Standardization of Sieves.—During the past month the problem of standardization of sand sieves has been taken up by the Bureau of Standards at Washington, D.C., with the object of preparing standard samples for testing, says *The Canadian Engineer*, Toronto. The bureau at present maintains standard cement samples for checking 200-mesh sieves, and these samples may be used for the determination of correction factors for such sieves, thus comparing them with the standards kept at the bureau. The difficulty in preparing a sample for the standardization of sand sieves is due to the fact that it is almost impossible to secure a material that will remain uniform. In a relatively coarse sample, such as would be required in the testing of sand sieves, there is a tendency for the various sizes of grains or particles to segregate and not remain uniformly distributed. The problem is, therefore, to devise some method of preparing a series of samples that will have absolutely the same size gradation. It is hoped that the investigation will yield some valuable results along this line and that progress in its solution can be reported in the near future.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in Italics.

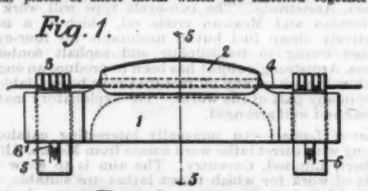
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

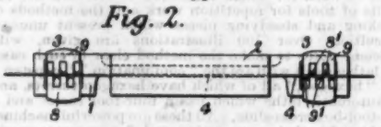
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

ELECTRICAL APPARATUS

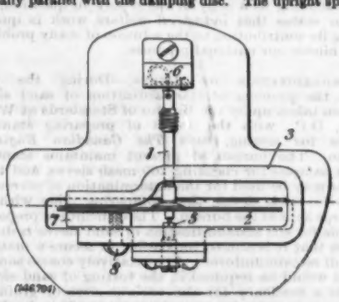
147,316. H. R. Rivers-Moore, Croydon, J. T. Burden, London, and W. J. Hawes, London. Electric Fuse. (7 *Figs.*) May 10, 1919.—The invention relates to electric fuse carriers of the kind in which the carrier is provided with contact blades adapted to be inserted in fixed terminal clips and in which the fuse wire is held in spring clips. According to the invention, an electric fuse carrier of the kind referred to is provided with two terminal pieces extending through the body of the carrier, one end of each terminal piece forming a projecting blade adapted to be inserted in a fixed terminal clip and the other end forming a spring clip to hold an end of the fuse wire. The carrier comprises a body 1 of insulating material, the part 2 forming the handle. The two sides of the body 1 of the carrier are recessed. The carrier is provided with spring clips 3, 3, which hold the fuse wire 4. The lower ends 5 of the spring clips form the contact blades which are inserted in clips on the fuse board to connect the fuse in circuit. Each spring clip is formed of two exactly similar plates of sheet metal which are fastened together at





their lower ends to form a contact blade 5. The plates are bent away from each other as shown in Fig. 3, and at their upper ends are bent over at 7. Attached respectively to the two parts 7, are parts 8 and 9, having a number of fingers 81 and 91 extending horizontally and then upwardly. The fingers on the two plates are staggered with respect to each other so that by pressing on the parts 7, they can be moved past each other to permit the fuse wire 4 to be inserted. On removing pressure from the parts 7, the plates spring back and the fuse wire is firmly gripped between the fingers. The carrier is provided with openings of V-shaped cross-section to receive the spring clips, the latter being inserted from the upper side of the carrier. Two outwardly-turned lugs 61, are stamped out of the plates which, when the clips are inserted in the carrier, spring outwards against the underface of the carrier, thereby preventing the clips being pulled out of the carrier when the latter is removed from the terminal clips on the fuse board. Each clip may be stamped out of a single piece of metal and be subsequently bent into the required form. (*Sealed.*)

146,794. J. Harris, Lafayette, Indiana. Electricity Meters. (3 *Figs.*) May 7, 1919.—The invention relates to electricity motor meters for alternating or direct current, and consists in a damping magnet having a polar portion adjustable with respect to the balance of the magnet and in a plane substantially parallel with the damping disc. The upright spindle 1



carries a metallic disc 2. In an alternating current meter this disc is not only an armature, but is constituted a damping disc by being mounted to turn in the field of a damping permanent magnet 3. A step bearing 5 supports the lower end of the spindle. The bearing pin 6 engages the upper end of the spindle. A soft iron pole-piece 7 in the form of a disc, upon one limb of the magnet 2, is spaced apart from the remaining pole of the magnet to afford the desired air gap in which the disc turns. An upright screw 8 passes freely through a magnet limb into threaded connection with the pole-piece 7. This screw is eccentric with respect to this pole piece, whereby when the screw is loosened, the polar disc may be turned to have more or less of it presented to the damping disc 2 to effect desired adjustment of the braking effect of the magnet, whereafter the screw is tightened. The result secured is substantially the same as that effected by the adjustment of an entire damping magnet. (*Accepted* July 21, 1920.)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

146,595. E. C. Hatcher, Finchley. Internal-Combustion Engine. (6 *Figs.*) April 7, 1919.—According to the invention, in an internal-combustion engine of the rotating sleeve valve type, the sleeve valve is held in position axially solely by a driving flange supported between the cylinder and the cylinder head, that is to say, directly in contact with these parts without intermediate packing, and the lower end of the sleeve valve is free or unsupported. 1 is a cylinder, the lower part of which is bored to accommodate a reciprocating piston 2. The upper part of this cylinder is enlarged or recessed to receive a sleeve 3, and is closed at its upper end by a head 4, a part of which extends through the sleeve 3, and at its lower or inner end for a short distance fits closely within that part of the cylinder 1 which is bored to receive the piston 2. The upper or outer end of the head 4 rests on the cylinder end to which it is suitably secured, for example, by studs, lateral support being afforded by a positioning flange 5. The sleeve 3, which has ports 6 formed therein so that it can operate as a valve, is thus located in an annular recess or chamber 3a formed between the cylinder wall and the head, in which the said sleeve valve can freely revolve. The lower or inner end of the sleeve valve is free or unsupported in an endwise direction, whilst in its upper or outer end an outwardly extending flange or collar 7 is formed which rests on

Fig. 1.

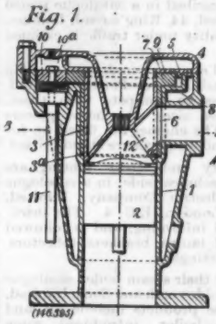
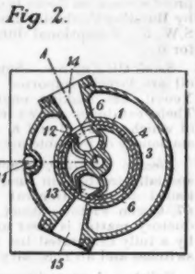
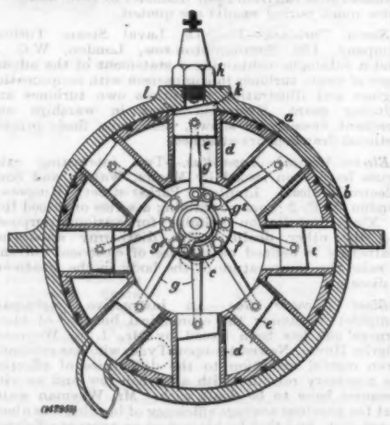


Fig. 2.



or is supported by a bearing surface 8 provided on the cylinder. This construction allows free axial expansion of the sleeve in the chamber provided between the cylinder and cylinder head. The cylinder head 4 encloses the outer end of the sleeve valve 3 and is furnished with a bearing surface 9 for holding the sleeve in place endwise. The flange or collar 7 is furnished with teeth gearing with a driving pinion 10 keyed on a shaft 11 having its axis arranged parallel to that of the cylinder 1, and geared at its lower end to the engine crankshaft. The pinion 10 is situated in a chamber 10a provided therefor, into which oil can be fed to lubricate the gearing and the sleeve, the oil collecting in the space 3a below the sleeve valve assisting in making the joint between the cylinder and the cylinder head gastight. The cylinder head 4 is provided with an inlet port 12 and an exhaust port 13 arranged opposite to corresponding ports 14, 15, respectively opening through the cylinder walls and having their centre lines spaced apart around the cylinder at an angle of approximately 125 deg. to 135 deg. in plan. By the rotation of the sleeve valve, the ports 6 therein are successively brought between the inlet ports 12, 14, and exhaust ports 13, 15, alternately. The gearing for rotating the sleeve is designed so that the sleeve is rotated at one-quarter of the crank shaft speed, and the circumferential dimensions of the ports are determined so that in conjunction with the angular separation of the ports in the cylinder and cylinder head, the opening and closing of the inlet and exhaust ports are properly timed for a four-stroke cycle. (*Sealed.*)

147,959. D. Doyle, Bristol. Internal-Combustion Engines. (3 *Figs.*) December 10, 1918.—The invention relates to internal-combustion engines of the rotary type comprising an outer casing, a rotor rotatable therein and having a plurality of reciprocal pistons contained within cylinders in the rotor



and connected to a stationary crankshaft round which the rotor rotates. The invention consists in an engine of the type referred to in which an opposed pair of reciprocal pistons is coupled to ensure symmetrical movement of the pistons and connecting rods. Within an outer casing *a* is a rotor *b* mounted upon a power shaft *c* of the engine is adapted to rotate. The rotor is provided with a series of cylinders *d* within which pistons *e*, connected to a stationary crankshaft *f* by connecting rods *g*, are adapted to reciprocate as the rotor rotates due to the eccentricity of the paths of rotation of the rotor and of the pistons respectively. The connecting rods are pivotally mounted in a common carrier *g*1, free to rotate round the crank and to ensure symmetrical movement of the pistons and connecting rods, the crank and common carrier are connected by an articulated link *g*2. At a point on the outer casing is provided a sparking plug *h*, which is adapted to serve each of the cylinders in succession and the pistons are curved or inclined upon their end faces so that in conjunction with a similarly-curved or inclined recess *k* in the casing they form an explosion chamber. The charge for the engine may be drawn in through the hollow crankshaft or other port, and an exhaust port *l* is provided in the casing *a*, preferably at a point almost diametrically opposite to the ignition device, the arrangement being such that during one revolution of the rotor each piston completes two strokes and respectively performs the functions of charging, compression and exhaust following upon explosion, so that the engine operates upon the two-stroke cycle principle. (*Sealed.*)

LIFTING AND HAULING APPLIANCES.

147,369. Lake and Elliot, Limited, Braintree, A. E. Lake, Braintree, and A. D. Powell, Braintree. Lifting Jacks. (10 *Figs.*) September 5, 1919.—The invention refers to improvements in lifting jacks of the kind in which a rack is extended from a base or pedestal, either by means of a lever or by means of a screw or worm gearing. The lifting jack comprises a rack *a* which supports a crutch *b* and is slidably housed within a base or pedestal *c*. At or near the upper end the said base or pedestal is enlarged, as at *c*1, to form an enclosed casing or housing for the reception of the lifting gear, which comprises a pinion *d*, worm wheel *e* and worm *f*. The two wheels *d* and *e* are mounted on a shaft *g* which takes a bearing at one end in a boss *c*2 in the side of the casing *c*1, and at its other end in a boss *h* in a removable cover disc *i* which fits and closes the side of the gear casing *c*, being kept in place by means of screws

Fig. 1.

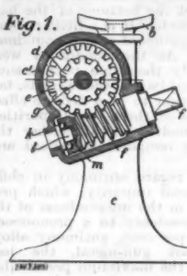
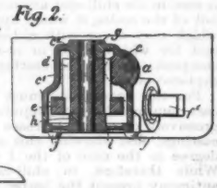


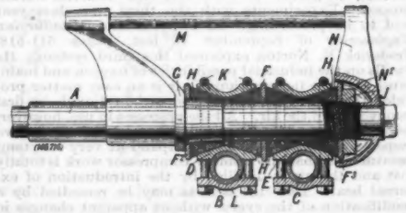
Fig. 2.



This arrangement makes the working parts readily accessible and facilitates their assembling. The two wheels are firmly secured together by internally shaping and slipping the one wheel *e* over the other one *d*, as shown, and they may instead of being mounted to revolve with the shaft *g* be mounted to turn freely thereon in which case the shaft would be suitably secured in one or both of its bearings *c*1 and *h*. To avoid the use of sustaining mechanism, the pitch of the threads on the worm wheel *e* and worm *f* is slow, so that the gearing is irreversible, or in other words such that it will sustain the load on the jack, whilst anti-friction balls *k* or other thrust bearing members are provided between the lower end of the worm *f* and the casing to ensure easy operation. These bearing balls *k* may conveniently run around a thrust stud *l* in the casing and a groove or race *m* in the end of the said worm. Rotation of the worm *f* may be effected through the squared end *f*1 of the worm shaft. (*Sealed.*)

MOTOR ROAD VEHICLES.

146,716. F. W. Mead, Ridford-on-Avon. Sidecars. (2 *Figs.*) July 3, 1919.—The invention relates to couplings for connecting sidecars to motor cycles. According to the invention, each of the coupling tubes carries a sleeve, which is bell-mouthed and mounted with a clearance upon a frame member of the sidecar. In each bell-mouthed end is fitted a rubber cone, and the two cones are forced towards one another to form a tight but resilient packing between the sleeve and the frame member. Where there are two couplings side by side, there is a single tightening device which may be a nut screwing upon the end of the frame member. The central frame member A of the sidecar projects forwards for the reception of the attachment of two coupling tubes B and C. For this purpose two sleeves D and E are threaded upon this projecting frame member A, with a washer F between the two and also at the outer ends as at F2 and F3. One of these, F2, lies against a stop on the frame member, which may be the bracket G on the frame member A.



Each sleeve D and E is bell-mouthed at each end, and in each bell-mouth fits a rubber cone H, which projects slightly from the sleeve. Upon the end of the frame member A screws a nut J, which, when tightened up, compresses the cones H and locks the sleeves D and E on the frame member A, but the rubber cones permit a small amount of resilience. Each tube B and C is attached to a sleeve D or E by means of U-bolts K which pass round the sleeve and clamp the tube up against the underside of the sleeve by means of a clamping plate L. The projecting part A of the frame member is stiffened by a bridge M, extending from the bracket G to an arm N bolted upon the end of the frame member. This bridge is constituted by the bolt or spindle which forms the guide for the springs at the front of the sidecar. Thus the part which receives the strain of the couplings is stiffened and duplicated by means of the bridge M. The arm N forms at N2 a shield concealing the nut J for tightening the couplings. (*Sealed.*)